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WILLIAM L. McFARLAND, M.D.

Salmon of the Atlantic

By
William Landram McFarland

Foreword by
Barton Warren Evermann

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To the Memory of

WILLIAM C. McFARLAND

GENTLEMAN, SOLDIER AND SPORTSMAN

FOREWORD

The most important family of all the fishes of the world is the Salmonidæ, the family to which belong the salmon, the charr, the whitefish and the trout. There are in this family more than one hundred species. They are all confined to the northern hemisphere, and chiefly north of the fortieth parallel where they are usually abundant wherever suitable waters are found. Some of the species are anadromous, living and growing in the sea, and entering freshwaters only for spawning purposes. Still others live in streams or running brooks, entering lakes or the sea as occasion serves, but not habitually doing so. Others again are lake fishes, approaching the shores or entering streams in the spawning season, at other times returning to waters of considerable depth.

To the student of species and of problems of geographic distribution and adaptation to environment, the Salmonidæ are perhaps the most interesting and important of all fishes. There is no group or family of fishes that supplies better ma-

terials for the study of the effects of geographic or physiologic isolation, or which presents more curious and interesting facts in their life histories than do the various species of Salmonidæ.

To the angler, the Salmonidæ are of surpassing interest. Among its members are more game fishes than in any other family, perhaps as many as in all other families combined; and many of them are the greatest of all game fishes.

Commercially, the Salmonidæ constitute the most important family of fishes. The commercial catch of salmon in Alaska and elsewhere on the Pacific coast of America alone amounts to more than $40,000,000 annually; under proper regulation it could no doubt be increased to, and maintained at, double that amount. And if we add to this the catch of lake trout, whitefish, Atlantic salmon, and trout throughout America, Europe and Asia, the total will mount perhaps to a hundred million.

The best known and, to the angler, the most interesting species of the family is the Atlantic Salmon, *Salmo salar*, about which Dr. McFarland has written so entertainingly in the following pages. He gives not only the early history of the Atlantic Salmon in America but he goes back to

even earlier times and gives us an account in charming style of what was known of it in Europe in Cæsar's days. And then there follow chapters on Anatomy and Physiology of the salmon, written in proper detail and with scientific accuracy, the Diseases which poor *Salmo salar* is heir to, and then, best of all, a very full account of the Habits of the salmon. And finally, a very complete Bibliography that will prove extremely useful to those interested in this interesting fish.

Dr. McFarland came well equipped to the writing of this book. As a child, he had wide and varied experience in hunting and fishing in many western states. This gave him an outdoor life and developed in him a love for nature and the spirit of the naturalist. Later, when a student in various laboratories in Europe and America, he acquired the spirit and the method of science.

There followed many years when he went a-field and fished for the Atlantic Salmon in many waters. He fished not only that he might feel and measure the thrill and tingle that come to muscle and nerve from the dash and pull of salmon, bass or trout, but he also fished that he might secure material for his study of the anatomy of the salmon; for, when he went a-field he carried with him the neces-

sary laboratory equipment for his anatomical and chemical studies.

And in this spirit and manner was the "Salmon of the Atlantic" written. It will be welcomed by all lovers of nature, anglers, and students of fishes as a real contribution to our knowledge of this important species.

Barton Warren Evermann
Director, Museum California
Academy of Sciences
Sept. 16, 1924 San Francisco, California

PREFACE

Some years ago, after my first season on a salmon stream, I searched the book shops for a volume that had in it the varied information I desired concerning Atlantic salmon. As there was no such book available, I decided to write one, not appreciating at the time what a task I had set for myself. The literature pertaining to Atlantic salmon is enormous, and many articles and works have been consulted and drawn upon. To select some of the good material and try to arrange it for a purpose of this kind has been difficult. To avoid protracted argument and too frequent intrusion of personal opinion and experience is never easy for an angler. If the book, such as it is, gives pleasure to any fellow sportsman, or adds one recruit to the ranks of conservationists, the labor of its making will be repaid.

To Miss Dorothy H. Decker, B. A., I am much indebted for valuable assistance with references, and in preparation of the manuscript.

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SALMON OF THE ATLANTIC

SALMON OF THE ATLANTIC

CHAPTER I

EARLY EASTERN HISTORY

THE salmon family began to swim the waters of the globe in the Pre-glacial Era. During succeeding periods, by that wise provision of Nature which governs all living matter, their bodies gradually adapted themselves to changing physical conditions until there were produced, many years before man, the fishes we know today as Salmonidæ. In the development and distribution of Salmonidæ, a kindly Providence allotted to the North Atlantic and its tributary rivers *Salmo salar*, or as it is sometimes called, the true salmon.

Men of the Stone Age and their successors speared salmon in those lovely reaches of the Thames now stirred with racing blades and softly rippled by the sluggish punt, and many a salmon was startled by the clang of Roman armor as Caesar's legions marched the meadow lands and forests of ancient Britain.

To the Romans, the sight of these leaping fish should have been a familiar one as they then swarmed the streams of Northern Europe and doubtless swam in numbers beneath the famous Rhine bridge. Unfortunately Caesar goes but little into detail concerning the fauna of invaded territories, nor does he discourse on the art of angling, so we are in darkness as to whether his men resorted to the artificial lure of the Greeks, as later described by Aelianus, or secured their fish by native methods. Being good foragers and depending as they did largely upon the resources of the country, the legionaries must have found the easily obtained and abundant salmon a wholesome and important addition to their dietary. However, salmon could not have been considered of surpassing delicacy as it is not included in the lists of rare food stuffs which passed in a constant stream from the outposts of the Empire to the kitchen fires of Rome.

When the Romans invaded and occupied Northern countries, they encountered many birds and fishes unknown in the Southern latitudes of Europe. Some of these they named, being guided by what appealed to them in form, action, color or song. In the case of the salmon, this casual method of identification produced a not unhappy result, for

THE ATLANTIC SALMON (from a U. S. Government engraving)

Salmo (the leaper) conveys a popular, if unscientific, conception of the fish and was in common usage at the time Pliny "the Elder" wrote "Naturalis Historia" in which is the first known mention of salmon as such.

The Pliny reference is curious because of its brevity and the fact that this observer of more than ordinary perception should allude to salmon of Aquitania rather than to those of the Rhine to which his attention must have been frequently attracted during the construction of the Rhine-Maas Canal. Even though Pliny was more concerned with the quantity than quality of his data, the passage—"In Aquitania again, the river Salmon is preferred to all fish that swim the sea"—leads to conjecture that Romans of his day regarded the fish as of local importance only.

After Pliny some two hundred years elapsed before salmon was again mentioned in Latin literature; but then appeared a poet whose pen should stir the pulse of every lover of the gentle art of halieutics. Decimus Magnus Ausonius, an ecclesiastic and scholar, spent much of his life in Bordeaux and perhaps mellowed by rich vintages from the neighboring hills, composed "Mosella" with the warmth and abandon of an Elizabethan

at midnight in the Mermaid Tavern. Though there is some doubt whether the writer had in mind salmon proper or his cousin the trout, a garland should be awarded him for the lines—"Nor must I pass you over, O Salmon, whose flesh gleams scarlet; the sudden lashes of your broad tail are borne up in ripples from the bottom to the surface of the stream and your hidden strokes are betrayed in calm waters; your breast is clad in an armour of scales; your head is smooth; and you are a fat dish for feasts where choice is difficult; you will bear a long wait without going bad; the spots on your head mark you out; and your prodigious belly quivers with the weight of your fat sides."

In following the subject further one is led to the realm of English literature, to English statutes, and to Parliamentary chapters, which is not hard to understand when the economic value of the salmon and the place of honor it occupies as a sporting fish are appreciated. The recognition of salmon as a commodity in England dates back at least to the Saxon Kings, for in the laws of Ine it is ordered that the fish be given in part payment of certain land taxes.

Having in mind our own tax difficulties it is easy to imagine that this law extended the use of

traps and nets for no man would angle or spear for his tax money when it could be obtained in greater abundance with less effort. The development of traps and extension of their use proceeded until necessity for some regulation became apparent and Alexander provided for clearance in mid-stream by declaring—"That the streame of water sall be in all parts swa free, that ane swine of the age of three zears, weel fed, may turne himself within the streame round about, swa that his snowt nor taile sall not touch the bank of the water."

By 1285 the need of seasonal protection was realized and under Edward I was devised "A penalty for the taking of Salmons at certain times of the year." In this statute are mentioned a number of streams out of which it was forbidden to take salmon "from the Nativity of Our Lady unto St. Martin's day;" it also forbids the taking of young salmon "by nets and engines upon the midst of April unto the Nativity of St. John Baptist." Truly Edward let the punishment fit the crime, for it ranged from burning of the fisherman's gear to imprisonment for one year. But even more dear to the heart of our choleric angler is the memory of James II of Scotland as he discouraged the practice of taking salmon out of season by sending

the breakers of that law to the undiscovered country through which flow no salmon streams.

The source of information upon which these laws were based is not manifest but doubtless such people as foresters, game wardens, and some landed gentry had noticed the process of spawning and were familiar with the months when it occurred, as well as the time required for hatching of fry. Such observations brought them in turn to recognition of the necessity for a legal definition of the size of fish which could be taken. During the reign of Elizabeth the minimum was fixed at 16 inches, a not excessive limitation for Scotch and English fish. After Elizabeth, salmon laws appeared with increasing frequency in the Statutes and Parliamentary chapters of England; some of them were not modified or repealed until the reign of Queen Victoria and some are perhaps still unchanged. These laws are of unusual interest because of their antiquity, their frequent soundness, and their repeated mention of English streams from which the fish has long since been driven by nets, greedy anglers, dams, and mill and sewage pollution.

It would seem that the female of the present day regards with more satisfaction the achieve-

ments of her sex than she does its natural charms even though the latter are freely displayed, so while man may express surprise, Citoyenne takes it as a matter of course that the first book on angling published in the English language should have been the work of a woman.

Dame or Lady Juliana Berners, who is supposed to have been a Prioress, was a person of uncommon erudition for her time and discussed armory, farriery, hawking, hunting, fishing and medicine in a manner agreeable to readers of the period. "The Treatyse of Fysshynge" attributed to her was "Impryeted in Flete Streete at ye Synge of Ye Sonne, by Wyken de Worde" in 1496 and contains the following reference to salmon—"For by cause that the Samon is the moost stately fyssh that ony man maye angle to in fresh water. Therefore I purpose to begyn at hym. The Samon is a gentyll fyssh: but he is comborous for to take. For comynly he is but in depe places of grete ryuers. And for the more parte he holdyth the myddys of it: that a man maye not come at hym. Ane he is in season from Marche until Myghelmas. In whyche season, ye shall angle to hym wyth thyse baytes whan ye may gete theym. Fyrste wyth a redde worme in the begynnynge and the endynge of the season.

And also wyth a bobbe that bredyth in a dunghyll and specyally with a souerayn bayte that bredyth on a water docke. Ane he bytith not at the grounde, but at ye flote. Also ye may take hym: but it is seldom seen with a dubbe (given in glossary as an artificial fly) at suche tyme as whan he lepith in lyke forme and manere as ye doo take a troughte or a gryalynge. And these baytes ben well prouyd baytes for the samon."

Apparently Lady Juliana supplied the English demand for information on salmon during the sixteenth century or perhaps writers of the time were too gallant or discreet to take issue with the fair Prioress as no mention was made of the fish aside from an occasional reference in poems and plays by Drayton, Dekker and Shakespeare during the close of the sixteenth or in the early years of the seventeenth centuries.

The foundation of our present rich bibliography on all forms of sport practiced by the Anglo-Saxon was laid during the seventeenth century as the mechanics of printing were simplified, and books referring to salmon, produced during that period would fill a fair-sized stack. Many treat of a variety of subjects related to rural life, some are written in verse, and some use angling as a basis

for theological argument. They are of such rarity that early editions are in treasured collections of University and Museum libraries and knowledge of them is only gained through books of reference and a few reproductions, the most important of those which touch on salmon being by Bacon and Walton.

"A History of Life and Death" by Sir Francis Bacon, published in the year 1638, gave the age limit of salmon as being not much over ten years. This observation is one of unusual interest because of its confirmation through the present accurate measurement of salmon age by scale reading and its opposition to the popular belief then and now that these fish live a number of years, well over ten. The same author in "Sylva Sylvarum" goes somewhat into detail concerning the sense of hearing and sense of smell possessed by fishes; both of which problems still receive the attention of physiologists and psychologists.

In 1653 appeared the most widely read and most frequently reproduced of all books related to fish or fishing and the first real literary work to deal with the art of angling. As a matter of fact, Isaac Walton was more a litterateur and philosopher than an angler, and he used the subject of

angling as a background for the gentle expression of his philosophic views and a display of his knowledge of literature, to which qualities are due the rare charm of the "Compleat Angler."

It would seem a profanation to seek scientific data or accurate observation in the lines of Walton and one should accept what is found there with a feeling of reverence and gratitude toward the unusual mind whose production has given hours of pleasure to many generations of booklovers and sportsmen. Of the salmon his ideas could not have been obtained at first hand, for had he angled for what he terms "the king of all fresh-water fish" surely he would have devoted more space to it. His chapter treats in a general way only the habits of salmon as understood at that period and exhibited in the framing of laws for its protection, but a sly humor is evident in the reference to marking of young fish by tying ribbons to their tails.

Walton informs us that some form of reel had been devised to meet the runs and lunges of the fish and that a guide on the rod tip was considered advisable. As a lure he suggests the fly, presumably artificial, for according to Cotton, fly tying was then a growing art. The common garden angleworm is highly recommended, though it must

be well cleaned and kept several days in moss. He does not entirely approve of the custom of smearing worms with some foul smelling oily combination although he gives formulæ for such mixtures.

Observations on salmon, however, were not entirely confined to England during this period as Olaus Magnus, Archbishop of Upsala, Sweden, devoted an interesting if not scientific chapter to the fish in "A Compendious History of the Goths, Swedes, Vandals and Other Northern Nations," an English translation of which appeared in London in the year 1658. The English printer of this remarkable book, in his letter of dedication to some gentleman of title, announced the fact that its contents were astonishing, and so they are. Were the good Archbishop living in this age, when hunting of nature fakirs is a favorite indoor sport, he would lead a most unhappy existence as he would be taken to task for many of his statements concerning man and beast. For the salmon he had great respect and he endowed them with almost human intelligence in his description of their upriver migration in military column, old wise fish scouting ahead and young fish swimming on the flanks and as a rear guard. Their strength, he said, was prodigious, for by taking their tails in their mouths

they were able to leap ten feet above the surface of the water. Smoked salmon, he found most acceptable, especially to the traveller, and it still is in Sweden, to judge from its place of honor on the smorbrod table.

Following Walton in the British Isles have been many writers and there is no phase of salmon culture, preservation or angling which has not been treated in a delightful manner by a score or more of Scotch and English fishermen and scientists. In the North, the canny Scot digs with grim perseverance at practical matters, while Southward where softer breezes blow, his gently nurtured neighbor is more aesthetically inclined. The Scotchman may, like Raeburn, grudgingly add a rabbit to his picture but the Englishman is a true Reynolds in his desire to combine landscape with portraiture, and so between them they have achieved a rare literature, in which one can tread the paths of science, or

> "Fields and meadows green may view,
> And daily by fresh rivers walk at will."

CHAPTER II

WESTERN HISTORY

"THERE was no want of salmon, either in the river or the lake and larger salmon than they had before seen" is written in the Saga of Erik the Red, and what matter if his son, Leif, landed west of Cape Cod or north of Gaspé, the chant told of a new world whose waters teemed with fish. It was fitting that the Norsemen should have had with them Haki and Hakja, two Scotch people "swifter than beasts," who explored the land for three days as pioneers of a hardy race so largely instrumental in development of the North American Continent.

It was also fitting that the "king of fresh-water fish" should have been first seen on this side of the Atlantic by the only early voyagers who nosed around through unknown seas for pure love of adventure. No hunt for quick passage to riches of the East was theirs; no lust for gold; no desire to add new possessions to a sovereign realm: they were driven by a spirit which still moves some of their descendants to winter in arctic ice and enables

them without aid of compass to home a summer way to the sunds and fjords of Scandinavia.

Following the Norseman sailed a swarm of sea rovers whose names are trying to the school boy memory and whose efforts have furnished historians and geographers with endless material for dissension. To the ones who voyaged north, the cod fish made most frequent appeal, but there is from time to time some mention of the salmon as "massimamenti di salmoni," noted by Cortereal as he passed north from Newfoundland, and in Cartier's familiar description of the St. Lawrence, Gaspé and Bay of Chaleur. So when Hakluyt outlined a solution for several English social and political problems in "A Discourse on Western Planting," he quoted Cortereal and, listing the flora and fauna of North America by latitudes, placed salmon near the sixtieth degree as an attraction to ambitious emigrants.

Of the various fishes, cod were reported in such abundance by the Cabots and Cortereal, that English, French and Portuguese fishermen were moved to try the waters of Newfoundland, where meeting the several races sowed that seed which yielded a bountiful harvest of fishery disputes through many succeeding years.

Apparently these early fishermen had neither inclination nor leisure to heed Hakluyt's advice and "distill" in the savage mind the "swete and lively liquor of the gospel." On the contrary they were fully occupied in protecting their interests and skins from avaricious raids of sea-faring brothers of other nations, when not conducting such raids themselves.

Those were robust days of fishing; fleets based on armed ports, admirals commanded, and guns were as essential as nets and other gear. Naturally this form of sporting commerce afforded the English such pleasure that they exhibited great zeal in its pursuit and rich cargoes of fish went home with glowing accounts of mighty schools of cod and heavy runs of salmon.

In the course of time the stories reached Puritan ears, hence, according to an eminent Newfoundland historian who cites Winslow, the little band sailed west to fish and not as popular fiction has it, in search of a place to pray in peace and kill Quakers at leisure. Be that as it may, they founded a prolific line of wicked Yankee fishermen, who stole many cod and salmon and have been regarded as pests by the Maritime Provinces, but our northern neighbors may rejoice for the sins of the Pil-

grim Fathers are now being visited on their sons who indeed "know not at night where to have a bit in the morning."

Devastating home streams kept American fishermen fairly occupied and during pre-revolutionary days and for some years later, their squabbles were usually confined to cod and herring.

In the destruction of salmon, market fishermen and greedy anglers of the United States were more than assisted by mill refuse and the numerous dams thrown across every brook and river. It is a curious paradox that the greatest sporting race in the world should kill out game as it goes, either as a recreation, for commercial purposes, or through absolute disregard of living matter in its treatment of lands and waters.

The statement can be made without fear of contradiction that no fish, flesh, or fowl can long exist in or near English speaking communities, unless protected by stringent laws and careful guardianship. For example, it is not necessary to turn to the streams of England or the early recognition in that country of the necessity for game protection; our own deserted plains, gutted rivers and eleventh hour legislation are sufficient evidence.

Salmon limits are now authoritatively given as

Cape Cod and Ungava Bay (salmon are abundant in the rivers on the East side of Hudson's Bay) but it could, with much truth be said, that the fish have practically ceased to run in the rivers of the United States. The Connecticut River, whose fairway was in former years blocked by salmon, now wends a limpid course, disturbed only by mill and sewage débris from the towns which line its shores.

"An Act to prevent the taking and destruction of salmon in the Hudson River" (1771), also a report of the "Committee on Agriculture" in relation to the "Petition of Robert L. Pell, concerning Salmon Fisheries in the State" (Albany 1857) are indications of the early depletion of such fisheries in the state of New York.

A very small number of salmon still enter the rivers of Maine but they are making a last stand and are not sufficiently numerous to be of either commercial or sporting importance except in the vivid imaginations of compilers of summer resort literature.

That these salmon or any other game fish still exist in the streams of the Atlantic States can be traced to the untiring efforts of a few scientists and workers in National and State Bureaus of Fisheries

and the occasional citizen with sufficient foresight to appreciate the vital importance of conservation of natural resources. Such Davids wage a never ending battle with our perennial crop of vote hunting Goliaths who, by securing stream privileges for constituents and assisting them in evasion of law and invasion of property rights, throttle even fish with the slimy hand of politics.

Fortunately, the salmon fisheries of Canada have not run so rapid a course and since Denys found "a little river which I have named Au Saumon," to the present day, they have yielded to their possessors a comfortable annual income.

Because of the salmon's importance to that part of the people which looks to the sea for maintenance, its story is woven in most narratives and histories of Quebec and the Maritime Provinces, from Cartier, Denys and La Hontan, to the excellent historical and semi-scientific publications now issued for educational purposes by Dominion and Provincial departments in control of the fisheries.

In these histories and narratives, which lead in turn to wider reading, one follows well known streams and learns of those whose names are new, in addition to acquiring historical knowledge of boundary disputes not usually explained in detail,

A SALMON POOL IN NOVA SCOTIA

privateer forays not generally mentioned and many matters related to Colonial history and international differences.

Some histories written in the United States and Canada are well to avoid when seeking comparison for data, for writers of them appear to have been less concerned with record of fact than display of invective which they carried to such a degree that they are probably still engaged in muddy battles on the banks of the Styx.

For the sake of the fish, we on this side of the line should be glad that the original claims of the United States in the Northeast Boundary Dispute were not allowed, as the land included the head waters of the Restigouche on a map which is a model of inaccuracy. From an equally sporting point of view, Canadian anglers may regard with satisfaction the settlement of the Northwest Boundary Dispute, concerning which one of their historians says—"Our Ambassador at Washington, who was also a sportsman, without much regret, surrendered the Columbia River, because salmon in it were said to be so spiritless as not to take the angler's fly."

To name the original salmon rivers of Canada would merely be cataloguing streams between the

St. Croix and Ungava Bay, for every current had its yearly run of hundreds of thousands of fish. On fish in such vast quantities, the native American with his spear and crude trap made no impression and the first white men entered what could be called virgin fishing waters. To these waters went occasional fishermen from England and the Colonies before the strenuous early days of the Halifax Settlement, but no systematic fishing could be attempted because of the proximity of French colonies from which armed vessels preyed upon English commerce.

By capturing Louisburg, the principal French naval base, way was opened for more rapid colonization of Newfoundland, Prince Edward Island, and what are now the Maritime Provinces, and at the same time French vessels were deprived of sheltering ports outside the St. Lawrence River. Coincident with these inroads upon French possessions was the gradual acquisition by England of that naval supremacy which afforded protection to merchant and fishing vessels and fleets that sailed under its flag.

Thus, free to roam at will, it was possible for fishermen to turn their attention to the systematic taking of fish in waters of the Western Atlantic

with an assurance bred only through knowledge that their cargoes would reach home or friendly ports in safety. Had any number of men engaged in this form of fishing, the industry would have been short lived, as they stretched their nets and weirs from bank to bank and stopped everything that swam. However, their modest cargo spaces were soon filled and the nets drawn, giving sufficient clearance in midstream for subsequent runs of fish to reach the spawning grounds and partially or wholly offset the wastage.

In that part of Canada still controlled by the French, there was no such well organized taking of salmon for market purposes, as French fishing vessels were not having happy voyages either with or without cargo; the wants of the colonists were limited; and though it was said the "Gentilhommes spend much time in fishing and hunting," it cannot be imagined they did particular damage even in the immediate vicinity of their settlements and towns.

Following the English capture of Quebec and Montreal, the "Company of Merchant Adventurers Trading into Hudson Bay" found wider scope for its activities and projected tentacles into regions hitherto inaccessible because of French occupation.

In Canadian histories, criticism of the Hudson Bay Company and its methods is sometimes caustic but in the handling of salmon rivers, it is given credit for exercising a protection which, though casual, was efficient, in that it confined taking of fish to company people, thus preventing such wholesale devastation as occurred in many rivers.

The wants of the Hudson Bay Company were limited to supplies for their own employees and an occasional cargo for export, so various streams were benefited by its negative guardianship, until the expiration of its river leases and the abandonment of the King's Posts in Lower Canada.

Some idea of the rapidity with which salmon were being fished out during the early years of the nineteenth century may be obtained from the statement of Adamson, that while the methods of the Hudson Bay Company were wasteful, were its protection withdrawn for a single season, all salmon would in that time be removed from its leased rivers by skillful fishermen from ports of Canada and the United States. Had natural obstacles not occasionally prevailed, it would be impossible to conceive how a single salmon could have won by the avaricious net fishermen in the streams of

Canada, to form a nucleus for rehabilitation when protective measures were adopted.

Happily there are seasons when high water, gales, drifting seaweed and deposits of marine vegetable matter prevent drawing of the nets and it must have been during these years that some streams were saved. But all were not fortunate, for the mouth of the St. John no longer gives forty thousand fish annually nor can four hundred thousand pounds be tinned in a season at the mouth of the Miramichi.

Legislation concerning salmon fisheries in Canada began at an early date with Act 47, George III, Chap. 12, 1807, devising certain restrictions for net fishing and spearing in the Restigouche. In recent years it has become somewhat complicated through division of Dominion and Provincial control and the inevitable legal discussions which surround all matters pertaining to riparian rights. Prior to 1867, each Canadian Province had exclusive control over all fisheries and fishing rights within its boundaries and was supposed to base its regulation on Act 22, Vict. Cap. 86, after the passage of this act in 1858. The British North American Act, by giving to the Dominion, exclusive jurisdiction and legislative control over in-

land and sea coast fisheries and river and lake improvements, caused so much conflict between Dominion and Provincial legislation, that the matter was finally taken before the Privy Council of England which, in 1898, decided that the enactment of fishery regulations and restrictions is within the exclusive competence of the Dominion Legislature and is not within the legislative powers of Provincial Legislatures.*

*By an arrangement with the Dominion Government, the Province of Quebec controls its fisheries.

From a letter to the author from the Assistant Deputy Minister of Fisheries, Department of Marine and Fisheries, Canada, relating to the Regulation of Fisheries in the Province of Quebec:

1. The decision in the Supreme Court of Canada in 1882 in a fisheries case determined that the fisheries in the non-tidal portions of streams belonged to the riparian owners. Following this decision the fishing privileges in the non-tidal waters of Quebec were administered by the Province.

2. The decision of the Judicial Committee of the Privy Council in the Fisheries Reference of 1898 determined that whatever property rights in the fisheries were held by the Provinces prior to Confederation remained their property subsequent thereto, though the exclusive right to regulate the fisheries, no matter where they might be, is vested in the Federal Government. Following this decision the different sea-washed Provinces claimed the ownership of not only the estuarial fisheries but those along the three mile limit of the coast as well.

3. The further decision of the Privy Council of 1913, in the reference agreed to with British Columbia, determined that in all tidal waters there is a public right of fishery which comes under the exclusive administration of the Federal Government. Quebec claimed that this decision did not apply to that Province as it was largely based on Magna Charta and that Magna Charta did not apply in Quebec. Hence a further reference to the Judicial Committee to settle the question in Quebec was agreed upon and a decision was obtained in 1920, which was in effect that in that Province there is a public right of fishery in all navigable waters that are accessible by way of navigation from the sea, the administration of which comes within the exclusive purview of the Federal Government. It happened, however, that the land under the water, in the rivers and no doubt in the well defined bays, is the property of the Province, and fishing in such navigable waters is nearly all done by nets attached

The property rights of the provinces over all waters within their several limits, except public harbors, remained vested in the provinces and could be granted, conveyed or leased by them with such restrictions and regulations as they might impose as to the manner of holding, which would mean that the Dominion controls the waters; and the Provinces, the beds of streams.

Another interesting decision of the Privy Council of England concerned riparian rights in the Province of Quebec. It would seem that contrary to the English law which conveys to riparian owners on the non-tidal portions of rivers and streams, a right extending to the middle of the bed of the stream, in the Province of Quebec, the French law prevailed and under it there is no private ownership in the bed of a river which is floatable or navigable unless such ownership is especially granted. The question as to what was a floatable river came before the Privy Council in 1914 and it was decided that the term could not be applied to rivers which were unable to float at least

to the soil, so that dual jurisdiction remained. To put an end to this an agreement was reached with the Province of Quebec this year whereby it has undertaken to administer the fisheries under the Department's regulations in all the navigable waters, with the exception of those about Magdalen Islands. This agreement has no time limit.

cribs and rafts. The decision of 1914 was clarified by a decision of the same body in November 1920.

Laws relating to the salmon, passed by the Provincial legislatures, have been as a rule confined to increase of taxation and there has been no drastic action taken by them except in the Province of Nova Scotia.

Somewhat in advance of the spirit of the age, the Nova Scotian Legislature in 1916 threw open all salmon fishing within its boundaries, to citizens of the Dominion, sweeping away at one stroke the property rights of some of its public spirited men who had spent years of labor and much money, in restocking and restoring to usefulness long barren salmon streams.

The present existence of salmon in any quantity in rivers of the North American Continent is largely due to there having always been in Canada some men with a feel for the fish. Their numbers were at first small but their efforts and pens valiant in the cause of preservation. By circumventing bad laws and making use of good ones, they have been able to salvage from the débris of early devastation, a sufficient number of streams in the provinces of New Brunswick and Quebec to afford sport for the angler and a comfortable yearly in-

come for those who own netting privileges along the shores of bay and estuary.

It must not be imagined that the way of these men has been smooth; on the contrary, they have encountered many obstacles, not the least of which is the inherent tendency of every man with Scotch, English or Irish blood in his veins to consider it his undeniable right to dam streams and dispose of refuse as he may see fit and which makes him, whether he cuts logs or coupons, inclined to take for his guidance a passage from a complex Scotch decision on Crown Fishing Rights, to the effect that "the salmon itself, like other animals, feræ naturæ, becomes the property of the captor, even though he be one who has no right to the fishing."

With the French and Indians there have also been difficulties because the former chafe at anything savoring of English rule and the latter look upon all tenants of forest and stream as theirs for the taking. They have on the other hand been favored by the comparatively unsettled country through which the streams run and to no small degree by the assistance which they receive from all owners of fishing waters and leases.

In the work of restocking and guarding rivers, the cooperation of owners and leasers has proved

most valuable, as can be appreciated in consideration of the present condition of the Restigouche, officially reported in 1880 as having fishing for four rods, and that finest of all American salmon rivers, the Grand Cascapedia. An additional helpful factor has been the resident of the river districts who realizes the value of well regulated fisheries in a country which does not lend itself to extensive farming or stock raising on a remunerative scale.

It is possible for owners and leasers of salmon water to obtain a much more efficient and extensive guardianship than any government is willing to buy, and it is also possible for these people to limit the number of fish taken by rods through club rulings, which members are compelled to obey.

There is further benefit to the stream by service which Riparian Associations render, in seeing that laws regarding nets are not flagrantly violated or from the purchase of netting privileges, as at the mouth of the Grand Cascapedia.

The fruits of cooperation between officials and owners are realized on examination of statistics giving the value of fresh market salmon taken from the waters of New Brunswick from and including the years 1909 to 1914, as they show the minimum annual value to have been $222,087 (1911), the

A NEW BRUNSWICK SALMON POOL

maximum annual value to have been $269,775 (1910), and the average annual value of $242,-910.

In marked contrast are statistics which cover the same product and period for the province of Nova Scotia. Though having a more extensive coast line, infinitely cheaper transportation and easily accessible markets, its average annual income was only $112,550, the maximum $144,586 (1911), and minimum $88,784 (1909).

These figures which are taken from the Annual Reports of the Fishery Department of Canada presumably do not include the many thousands of dollars spent in New Brunswick each year by rod fishermen and it may be said of them that, as they cover a limited period, they do not afford an accurate comparison of salmon fisheries of the two provinces. Such a statement would, however, be open to question for, in the five years considered, there were good seasons and bad seasons in each district, neither war prices nor war conditions prevailed, and New Brunswick streams were being built up through official care and private guardianship, while all except a few of those in Nova Scotia were suffering from lack of both essentials.

As has been proved in Scotland and England,

salmon fisheries cannot be preserved, where people live, without the aid of rod fishermen and they are most successfully maintained when rod fishermen, net fishermen and government officials, aided by good laws, work in conjunction and regard the matter from a purely pound of fish per year point of view. A recent demonstration of this has been the rehabilitation of the River Wye, now yielding a satisfactory yearly return to rod and net.

Were all matters related to fish and fishing in Canada under the direct guidance of men of proved ability in the departments of fisheries, there would be little cause for anxiety as to the longevity of salmon fisheries, so far as human power to control such affairs is concerned. The restocking of streams, observation of habits, investigation of disease and other intimate and essential details connected with the salmon, receive from them an intelligent and scientific attention unknown and unappreciated by nearly all who take salmon for sport or profit.

Their principal compensation is that of personal satisfaction in the knowledge that they are doing a good work well and in contemplating the greatest yearly improvement in those waters where their efforts are the least impeded. Should the im-

possible happen and they be left free to work out their sound ideas, it would be merely a question of time until the Maritime Provinces and Quebec were converted into a second Scotland, but unfortunately the legislative tendency of the age is to destroy through its ill conceived plans for construction and from this evil no country seems to be able to escape. However, it is to be hoped that they can weather parliamentary brain storms and continue to build on the foundation they have so firmly planted; if not, soon will pass

"The silver-scaled fish, that softly swim
Within the sweet brook's crystal watery brim."

CHAPTER III

ANATOMY AND PHYSIOLOGY

Ichthyology had its inception in the modest work of Aristotle who, roughly arranging what the nets brought to his door, gave birth to a science which now has many ramifications. From a simple order based on very obvious characteristics has sprung a formidable classification with divisions and subdivisions too numerous and complex for consideration by any, save highly specialized students.

In the opinion of some, this classification is incomplete and unsatisfactory but discussion of its merits and demerits may be safely left to those learned gentlemen who, in many lands, devote their lives to the study of fishes, fresh and fossilized. It is sufficient for the casual reader to rejoice that the bullpout of his youth has drawn the appellation *Ameiurus nebulosus,* and be shocked to find that the lordly salmon of his autumn days possesses some rather plebeian relatives.

According to Bridge and Boulanger, the Atlantic

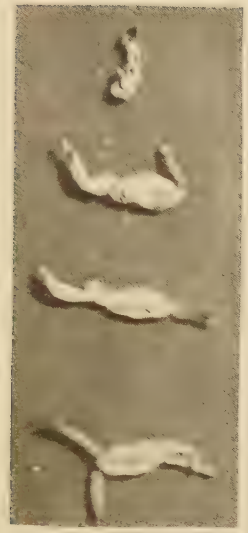
salmon is a Malacopterygian Teleostean, while Dr. Jordan appears to class him as a Crossopterygian Teleostean, the one meaning soft-finned bony fish and the other fringe-finned bony fish. His nearest relatives are the Pacific salmon, the trout and char, the white fish, the lake herring, and the ayu or sweet-fish of Japan. His adipose fin is an equally distinctive feature of the cat-fish and he is most readily distinguished from certain trout by the loss of some teeth with age, a law of nature more manifest above than below the surface of salmon waters.

It is necessary that a refined study of animal life should begin as nearly as possible with the inception of such life, or fertilization of the ovum by the spermatozoon. From this point, it is followed through successive multiplications of cells and their specialization, until a creature of the species under observation enters air or water more or less perfectly developed and prepared to begin its struggle for existence. Continuing through post-natal life, the workings of the animal machine in health and disease are considered, and eventually, its death and dissolution.

In these studies, such a number of sciences interlock that it is obviously impossible for any one man to be an authority on all, or more than a few men

on many, but fortunately, human interests vary, so each investigator selects that problem of life or disease which most appeals to him and contributes the results of his labor to the general fund of knowledge. Thus has been accumulated a vast amount of material relating to organic matter, from which material the student culls as much as he can absorb, and a writer that which he thinks will be of interest to his reader.

For the average salmon fisherman, it is enough to know that the female salmon will give about 900 eggs for each pound of her body weight and the male a proportionate amount of fertilizing milt. Spawning *en naturel,* the male and female poise side by side or rapidly replace one another over a trough which their tails have scooped in the gravel. The female "shoots" her eggs and the male his milt after which a layer of gravel is shoved in and the process repeated at intervals until the fish are stripped, freedom of the eggs from injury being largely due to the fact that the salmon egg will stand a weight of 5 pounds, 6 ounces without crushing. In the end, only a slight mound of gravel marks the egg repository and after a day or two in the vicinity, the parent fish desert the scene of



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5

1. Eggs. 2. Two-headed alevin. 3. Alevins—yolk sacs attached. 4. Parasitic capepods. 5. Parr.

their reproductive efforts, leaving the eggs to the mercy of nature.

For hatchery purposes, netted fish are stripped of eggs and milt which are mixed, and the fertilized eggs placed in troughs where they lie in streams of fresh running water. The lower the temperature of the water, the longer the time required for hatching, so the alevin or new born salmon may be from 90 to 150 days in the making.

When the tiny fish emerges from his parental shell, he brings with him emergency rations in the form of a yolk sac attached to his underbody and on the albuminoid content of this sac he subsists, until his small muscles are sufficiently strong to carry him from the lee of one sheltering rock to that of another and his diminutive digestive apparatus capable of converting into energy the particles of organic matter that come his way.

During this period his safety depends largely upon his protective coloring and the instinct that keeps him in crannies out of sight of his cousin the trout and his many feathered enemies. So strong is this instinct, that a few moments after the liberation of hatchery fry, they are carefully hidden and only with difficulty can they be detected,

tucked away in crevices and beneath small river stones.

A few months after birth, the fish reaches the parr stage, swims freely and fearlessly, eats what it can get, and too often provides a meal for predatory trout, kingfishers and water-fowl. The short, slender form with its black barred, red dotted back and silver underbody is the most beautiful of all little fish and is possessed of a vitality that is amazing; there is no salmon fisherman who has not from time to time swung one forty or more feet on a back cast, reeled him in and after disengaging him from the fly, been astonished to see him fin merrily away.

At the end of the second winter, he usually goes down to the sea and for several years disappears from the ken of man. On his return, he is by some called a grilse and by others a salmon, much seeming to depend on his size and weight, but whether grilse or salmon he is an adult, with fully developed muscles, bones, and appendages, and as such presents himself for anatomical and physiological consideration.

Scales. The first impression of the salmon as he lies before you is that made by his brilliancy of color. When the fish is examined closely it will

be seen that the scale covering is sharply divided by a longitudinal line running from gill-cover to tail, that the scales above this line seem dark, and those on the shoulder, or portion between the dorsal fin and head, centered with black dots or rough crosses, while those below the line are of a silvery hue. In reality, the fish's color is derived from pigment and iridescent substance held in the cells of the skin, and not in the scales, as may be readily ascertained if a scale is scraped with a knife blade and held up to the light.

The type of scale encasing the salmon is that known as cycloid; they are formed of delicate bony plates laid on a network of fibrous tissue, and are embedded so that their free margins project backwards. For physiological reasons, it is necessary that the scales have a certain play and slide freely, one upon another, so as not to interfere with the flexibility of the fish's body, or with the free discharge of mucus from the glands which lie directly beneath them and furnish their approximated surfaces, as well as those which are free, with a necessary lubricant.

Though popular conception of the motion of a fish is that of a rigid body propelled by the tail fin and balanced by the body fins, there is to the body

a serpentine motion best seen in the slow upriver progress of a long, slender fish. Whether moving backwards, forwards, or at any angle, the flexion of the body lifts the scales to a slight degree, just as the scales of a snake are lifted as it changes position. During this scale lifting, the viscid secretion of the mucous glands fills the interstices between separated scales and smooths the outside body surface which would otherwise be rough and retard speed.

The unbroken armor of scales with healthy skin beneath presents a barrier to the entrance of certain infecting organisms, notably the "bacillus salmonis pestis" which can only prepare an abraded surface for growth of *Saprolegnia ferox*, and inflict the fish with that scourge of salmon streams, the "Salmon disease." For external parasites, however, an intact surface presents no obstacle, as the "sea louse" attaches himself without difficulty, in all probability choosing the moment of scale lifting to reach vascularized tissue, as has been cleverly demonstrated is the modus operandi of the snake tick with its host.

In differentiating trout and salmon, it is well to remember that salmon have somewhat larger scales and "only 11 or 12 in a transverse series running

from the posterior border of the adipose fin forwards to the lateral line, trout having 13 to 16." That without some such means of differentiation it is not always easy to distinguish one from another, may best be appreciated after listening to protracted arguments between experienced and intelligent river men on the character of small fish.

Scale Reading. Thanks to the investigation of H. W. Johnston (Ann. Rept. Fishery Board for Scotland, 1904, 1906, 1907) it was satisfactorily demonstrated that the age of salmon, their years at sea and the number of times they have spawned could be determined with accuracy by examination of lines which are formed on the anterior and covered portion of the scale.

The method so auspiciously inaugurated by Johnston has been verified and elaborated by Phillippa C. Esdaile (Mem. and Pro. Manchester Lit. and Phil. Soc. 1912); J. Arthur Hutton (Results of Scale Reading 1909-1913. Reprinted from Salmon and Trout Magazine 1914); W. J. Menzies, Jr. (Ann. Rept. Fishery Board, Scotland, 1914); Dr. Knut Dahl (The Age and Growth of Salmon and Trout in Norway); Dr. Charles H. Gilbert in his painstaking and conclusive investigations of the Pacific Coast salmon; also others

of equal or less note, but it is to the ones here mentioned that those who desire more than a rough working idea of the subject are referred.

Johnston found that there were formed on the covered portion of the scale a number of more or less concentric lines arranged in bands according to the age and life of the fish. Beginning at the center of the scale or core which represents the earliest period of the fish's life are a few lines which form rings, one inside another. Around these rings, like nesting horseshoes, are formed during the parr-smolt stage a series of light and dark bands which are composed of fine lines slightly separated in the light bands, and lines closely packed in the dark bands. Further, the ends of the light band lines are free while those of each set of dark band lines are so close together as to be almost indistinguishable as separate units. Proceeding outward, the sea life of the fish is indicated in the same manner by broader bands composed of heavier lines and the spawning mark by a scar or lineless wavy band. The bands are designated as light and dark not because there is an actual difference in color but because rays of light pass more freely through the zones of well separated lines than through those of closely

SALMON SCALES FROM SPAWNED FISH

1. Spawning mark. 2. Winter zone. 3. Summer zone. 4. Winter zone. 5. Spawning mark.

SALMON SCALES FROM UNSPAWNED FISH

packed lines, the optical effect being one of light and dark bands.

In the summer when the fish is feeding and fattening and in an excellent state of nutrition, the growth of its scales is active, hence bands composed of lines formed during the summer period are bold and heavy and the spaces between individual lines are wide. In the winter when nutrition is poor, the scale growth is less active and lines formed during the winter period are less heavy and the spaces between them very narrow. Thus, summer bands are broad with widely separated lines and winter bands are narrow with lines crowded together. In addition the ends of summer band lines stream free while the ends of winter band lines almost merge on either side so that at their terminations the winter bands are indicated by closely packed strands between each set of free summer band line ends. When the fish spawns, there is evident disturbance of scale growth and the period is indicated by a wavy scar or line free band. As soon as it returns to the sea, line growth begins again.

For studying fish scales it is best to secure what is known as a dissecting microscope, as lenses of the standard instruments are too powerful. A child's toy instrument is sometimes amply suffi-

cient. Scales should be scraped from the shoulder of the fish and may be preserved in envelopes until perfect ones are obtained for mounting.

Before examining, wash the scale and free it of dirt by gently rubbing with a piece of lens paper or a soft handkerchief held between the thumb and finger. When clean, place it between two glass slides or cover slips, the ends of which may be fastened with rubber bands though such bands should not be used for permanent mounts as the glass quickly cuts the rubber. Put the slide beneath the microscope and adjust the mirror and lens until a clean sharp picture of the scale lines is obtained. This will require a little manipulation in order to obtain the proper light and proper focus. A mistake often made by beginners is that of attempting to work with too much light.

Assuming that these simple directions have been successfully followed and that you have secured a good scale, you will look down on a series of dark and light bands which in turn are composed of numbers of fine lines all nesting like a myriad of horseshoes graduated from the smallest to the largest size. For example, a possible arrangement would be as follows:

1st Summer:—A few rings and fine lines in center of nest.

1st Winter:—Incomplete circles outside summer band. Lines fine, ends closely packed on either side. Slightly dark band.

2nd Summer:—Half circles. Lines fine and slightly separated. Ends free. Light band.

2nd Winter:—Same as first but band broader. Dark band. Fish goes to sea.

3rd Summer:—Broad, heavy, widely separated lines with ends free. Broadest band on the scale. Light band.

3rd Winter:—Heavy lines closely packed. Ends closely packed. Narrow dark band.

4th Summer:—Like 3rd summer but lines not quite so bold or numerous, making for a narrower band than that of the 1st summer at sea. Broad light band.

4th Winter:—Same as 3rd. Band not quite so wide. Dark band.

5th Summer:—Beyond 4th winter band is a wavy irregular lineless band or scar, the spawning mark.

5th Winter:—Lines continue as before.

There are many scales with cracks or worn surfaces and many with "rests" or irregularities in the line arrangement, the latter indicating that the scale has been broken or injured and the normal line development temporarily upset. For these reasons, one should not be satisfied until perfect scales are found, nor should there be discourage-

ment when scales from the same fish do not seem at first to agree.

Skin. Beneath the scale covering is the skin, composed of several layers of cells and holding in its anatomy the scale beds and mucous glands, and along the lateral line some nerve buds or sense organs. In one of the superficial layers, which is reflected onto the inner and outer surfaces of the scales, are such pigments and "sparkles" as produce the external coloring of the fish, a coloring quite separate and apart from the distinctive "salmon pink" of the muscles.

Deposits of black and brown pigment in and around cells and iridescent cells called iridocytes in varying proportions and according to angle and degree of light, produce the blacks, browns and grays of the head and body above the lateral line, while iridocytes alone are responsible for that silver sheen of the underbody which artists and taxidermists try in vain to imitate. Melanin of the black and brown pigment and guamin of the iridocyte "sparkles" are both waste products of body metabolism and their distribution is as well adapted to the requirements of the fish as their utilization is an odd illustration of physiological economy.

In salmon skin there would appear to be more

pigment outside the cells than occurs in the skin of fish whose slower locomotion makes them very dependent on adaptive coloring for protection. The chromatophores whose several names indicate the color of their pigment (melanophore, zanthophore and erythrophore for black, yellow and red) have branching processes which they are able to extend and retract, thus spreading or concentrating their pigment and rapidly patterning their color to blend with that of their surroundings, common illustrators of such changes being sole, plaice and flounder which conform with great exactitude to the shade of the bottom upon which they lie.

For salmon, such pigment cells are not so essential, as it is sufficient that, when viewed from above, the back should conform in general to the color of the bottom, usually an indefinite brown, and that when seen from below, the silver sheen of the underbody should blend with the bright light in and over the upper water, thus making them hard to see from either direction.

That their color is to a certain extent adaptive is of course obvious from the variation in back shades which may be noted in fish from several rivers. The salmon, however, is a poor example of adaptive and protective coloring in nature so far

as his river life is concerned, for the longer he stays in fresh water, the darker he becomes and the less brilliant is his sheen, while at the same time his habitat shallows and clears and brings him into greater prominence. This probably follows the metabolic changes incident to spawning and a long fast.

Fins. For locomotion and steering, the salmon depends upon the motion of its caudal or tail fin, upon body position which makes possible the thrust forward or backward, and when on some courses in rivers, to his ability to utilize the force and direction of the current, as is frequently demonstrated by a hooked fish. For balance, he depends on the body fins and on the air bladder which contributes buoyancy.

The development or degeneration of the several fins have regulated themselves to the requirements of a fish that is forced by its mode of life to meet such extremes in swimming conditions as are found in the buoyant and relatively quiet waters of sea and estuary and the light, fresh water of the powerful currents it is compelled to breast on its way to the spawning beds.

According to number and position, the fins are called single and paired or median and lateral, all

median fins being single and all paired fins lateral. The median fins are dorsal or back fin, anal fin just to the rear of the vent, and caudal or tail fin. The dorsal and anal fins may be likened to center-boards or keels in that they are used by the fish to steady himself and without them he wobbles and rolls. Mechanically, their structure commands respect, consisting as it does of a series of bony chains whose internal links are buried in muscular tissue and whose external links, enclosed in a webbing of reflected skin, may be raised and lowered at will, much as a fan is opened and closed.

Anatomically, one speaks of a single chain or element, as a dermal fin ray and its tri-segmented, supporting radial, investigation of which is an instructive and inoffensive table amusement. If at dinner you happen to draw a portion of salmon back containing the dorsal fin in whole or part, it is possible profitably to occupy your time with a dissection during that course. By gently teasing apart the muscles, you will uncover in their beds a series of bony spines whose upper ends are slightly inclined. These are the proximal segments of the supporting radials and they are connected, as further examination will show, to short bony rods, the middle segments. Between the

middle segments and the long free fin rays can be found the small cartilaginous pads or distal segments that assist in forming the simple hinge joints on which the fin rays are raised and lowered by means of elevator and depressor muscles attached to their bases.

Back of the dorsal fin is a small, fleshy tab which the uninitiated are apt to consider a distinctive feature of the salmon. Originally, the dorsal fin extended the length of the body of the salmon, as it still does in some forms of fish, but requirements of the fish necessitated degeneration of the fin to its present form, and in the course of this degeneration it left behind, as evidence of its former glory, that little island of tissue known as the adipose fin, not confined, however, to members of the salmon family.

The paired fins, pectoral attached just behind the gills and pelvic further back on the body but both below the lateral line, are used almost exclusively for balance by salmon. Their dermal fin rays are similar in structure to those of the dorsal and anal fins, but their supporting radials are much more substantial, consisting as they do of bony plates attached to the skeleton for the pectoral fins and cartilaginous remnants of original bony

parts for the pelvic. By experiment, it has been shown that when both pectoral fins are removed, the fish goes down by the head; when pectoral and pelvic fins on one side are removed, the fish lists; when all paired fins are removed, the fish turns belly up. Thus, an additional reason for likening paired fins to the limbs of an animal that goes on all fours, rather than to the arms and legs of man, would seem to be that, while central control governed by specialized structures of the ear maintains equilibrium with the use of four limbs in the former, only two are necessary for such purpose in the latter.

The caudal fin which develops from a bifurcated to a truncate appendage is, as its usage requires, the most powerful of all fins and capable of a greater variety of motion. Its dermal fin rays are much longer and stronger than those of other fins and its supporting radials are heavy, ossified or partially ossified plates, directly connected with the terminal vertebræ of the spinal column. To the supporting radials and adjacent vertebræ of the spinal column are attached the long, powerful body muscles which flex, extend and, to a certain degree, twist the tail. Such motions, combined with expansion and contraction of the fan-like tail struc-

ture, are utilized by the fish to propel itself through its fluid environment and to gather momentum for its occasional excursions above the water surface.

Locomotion. While somewhat at variance with the usual order, it does not seem amiss at this point to treat a function intimately connected with, and dependent on, the tail and its fin. Briefly and at the same time comprehensively to describe the locomotion of a fish is difficult, nor can any such description be understood without the application of thought. If the motions of a fish swimming in a straight line are analyzed, it will be seen that the body throws itself into a series of lateral curves like those of a moving snake, while at the same time the tail swings back and forth from side to side. The curves which correct the tendency of the tail thrust to force the body off at an angle from its desired course, must of necessity be two or four or some even number to avoid defeating their purpose. In the body of the swimming salmon, there are always two curves, the cephalic or body and the caudal or tail curve, and as their concavities always face in opposite directions, it follows that their convexities always face in opposite directions.

The movement of the tail and its fin is likened to the horizontal figure eight sweep and the action of

an oar in sculling, the strokes being alternately feather and thrust. As the tail fin sweeps out from the long axis of the body, it presents a convex, non-biting surface to the water against which it thrusts in a flexion or non-effective stroke; as the tail fin sweeps in toward the long axis of the body, it presents a concave, biting surface in an extension or effective stroke, the ratio of effectiveness being about 1 to 2.

If you can imagine an elongated letter S wriggling along a straight line and swinging its lower bar from side to side, you will get some idea of how a salmon looks when traveling. Carrying the illustration further, it can be easily appreciated that the moment of least resistance is that during change of curves and sweep of tail when the body is straightened out on its axis. By reversing strokes or paddling on one side, the fish is able to back or change direction, and with almost imperceptible fin flutters, he can maintain a fixed trance-like position from which it is only too often impossible to move him with a box full of feathers, fur and tinsel.

Just how fast a salmon can swim or how high a perpendicular fall he is able to surmount are matters of interminable discussion. It is reason-

able to assume that his ability to climb falls is governed more by the momentum he gains in the take-off, than by his power to so speed up tail strokes that he can get a grip on the rapidly receding water.

Head. Salmon from several streams differ to a certain extent in contour of head and body. These differences are usually so slight that they are recognized only by men who have been raised with the fish, though in some instances they are sufficiently manifest to be appreciated by the ordinary individual when they are pointed out to him. Such head variations as are observed, usually confine themselves to the lower jaw, the head in general maintaining its resemblance to the bow of a submarine, with lines streaming into those of the body in such a manner that one gets the impression of a single rather than of two anatomical units.

Looking at the head one sees a mouth with teeth, two slight nasal pits or depressions between upper lip and eyes, two eyes, and two gill-covers. The bony and cartilaginous structures of the head, as the meaning of the word head is generally understood, are more numerous than those found in the human, though not always as complex in structure. Their functions are those of protecting soft parts

and furnishing rigid canals for nerves and blood vessels; and their number, form and arrangement are governed by the variety and extent of the work for which they were developed.

The mouth of a salmon is composed of upper and lower jaws, tongue and teeth. Upper and lower jaws are in turn formed of several bones and cartilages and the lower jaw is capable of a hinge-like motion only, in contrast to the partial rotary motion of the lower jaw of an animal that chews its food. On the margin of upper and lower jaws are reinforced rows of needle-like teeth which, as this fish is polyhyodont, are renewed as age and accident require.

In their minute structure, they are somewhat similar to the teeth of man and they have a disagreeable faculty of carrying on their surfaces some pus-producing bacteria which, from time to time, seriously infect the hands of boatmen who scratch themselves when working with the fish. (That this is so, is curious, for while infectious material carried into wounds by the teeth and claws of the cat family has caused the death of many a hunter, we do not expect a nasty infection from small salmon teeth that spend most of their time being washed by pure water.)

In the roof of the mouth and on the tongue are more teeth which, though not as strong as the jaw teeth, are still able to work for their lodging. Those in the roof of the mouth are on the head and shaft of a bone called the vomer and their presence or absence is one of the ichthyological guides to identification of fishes. Just why the teeth are so many and so placed, can possibly be explained by the use for which they are intended. As the salmon is concerned only with the grabbing and working in one direction of a very active and slippery object, the more hooks he is able to put into such an object, the less likely it is to escape him.

There has been a statement current for many years, and it has received much credence, to the effect that the reason food remnants are not found in the salmon caught with hook and line, is because the fish casts out the contents of his stomach after he has been hooked, some saying that they have seen small fish thrown into the air by salmon during their struggles. While nothing would seem to be impossible, the arrangement of a salmon's dental apparatus precludes the light and airy regurgitation of particles which have any degree of solidity, as they must pass over and under rows

of teeth so placed as to discourage the passage of solid or semi-solid substances in any direction, save that of the stomach.

It is true that small fish may be withdrawn from the mouth of a trout without apparent difficulty, and using again the analogy of the snake, we know that he can disgorge bodies which are much larger in proportion to his size than those swallowed by the salmon. However, a man does not appreciate the force he used in removing a trout's dinner and one has only to witness the laborious and unwilling process of a snake giving up part of a companion, to realize that the procedure, while it may not be unnatural, is neither rapid nor easy even though the snake facilitates matters by dislocating his lower jaw.

Gill-covers. Leaving for later consideration the nasal pits and eyes of the head features mentioned, there remain only the gill-covers and these may be dismissed by saying that they consist of stiff, membranous, bony plates, so articulated with other bones of the head, that they are capable of the very limited motion necessary to let through water which has bathed the gills.

Internal Organs: Heart, Blood Vessels and Respiration. Having studied the external aspects

of the machine, it can now be taken apart and its works examined, for unlike a well known automobile, it does not run on its reputation. The bony frame upon which the body is built is divided into an axis consisting of head and vertebral column and such portions already mentioned, as support the paired fins. On the vertebræ and ribs are laid most of the long muscles, and the ribs form a cage as it were, in which are contained most of those organs found in the chest and abdomen of man and also the organs of generation.

In this day of advanced surgery, there are people walking the streets, who, in the interest of health or science, have variously parted with a kidney, the spleen, stomach, many feet of intestine, a slice of liver, or portion of the brain, to say nothing of odd bits of anatomy here and there, but only one thing can render a man heartless and still keep him going, and that is a rotten disposition. Association of what is called soul with the heart, has come to us from the ancients, and instinctively, the heart is considered the one vital organ, hence, it is at the heart that every one first looks when he begins as a dissector.

So when you open your salmon, it will be the heart that first catches your eye and unless the fish

has been too long out of water, you will find that, symbolic of his courage, the heart still works its tiny pump in fruitless efforts to send a blood stream through the silent body.

It is a rule that the higher the type of development, whether physical or mental, the more complex are the body structures; thus, such vertebrates as man, monkey and dog require a four-chambered heart to supply their needs; those of a lower order like the salmon, however, can be taken care of by an organ which contains only two, for having no pulmonary circuit, he is not troubled with the necessity of sending blood from right heart through lungs to left heart.

The blood of a salmon passes from the auricle or collecting chamber of the heart to the thick walled ventricle whose rhythmic contraction is one of the principal factors in what physiologists call a vis a tergo or push from behind that moves the blood stream steadily along. From the ventricle, the blood goes into an artery called the ventral aorta that acts as a trunk line from which are distributed arteries to the gills.

Beneath the gill-covers on either side are sets of thin, red, rough-edged structures somewhat semi-lunar in form and so attached that their posterior

margins are free. These are the gill-lamellæ and to them comes the blood for aeration. Aside from being exceedingly slippery and cold-blooded, salmon have but one characteristic in common with politicians and that is a physical inability to keep their mouths shut; the fish goes through life to an accompaniment of jaw movements for the purpose of letting in water to wash his gill-lamellæ. The mouth is filled with water and then closed and its sides contracted, at the same time the gill-covers are raised and the lamellæ spread, allowing the water to pass over them and out of the body.

During these operations, there comes a constant stream of blood carrying in its current thousands of red cell porters who, when they reach the gills, pass in single file through a series of capillary vessels, giving up as they go, their loads of carbon dioxide and receiving oxygen in return. Emerging from the gills, the blood flows through arteries to the capillaries of the various body structures and eventually reaches the veins for its return journey to the heart, which, by means of 45-47 pulsations a minute, starts it on a new circuit.

Where a rudimentary knowledge of anatomy and bacteriology exists, there is never discussion concerning the advisability of bleeding a fish that is to

be preserved, and even if only a few hours are to elapse between the killing and eating, the flesh is infinitely better if as much blood as possible has been drawn from the body.

There are present in the mouth, gills and gastro-intestinal tract of the salmon, numerous bacteria, many of which are putrefactive. After death, these organisms work their way rapidly into the blood vessels and multiply faster and travel more easily when blood clot exists than when it is absent. Through these barrier-free channels, they are able to reach all parts of the body and effect its decomposition in such a short time that, as has been shown on the Pacific coast, a salmon kept at room temperature of 50-70 degrees, Fahrenheit, for 48 hours, is really unfit for eating. In consequence, you have the questionable satisfaction of knowing that, though to taste and smell the flesh of a fish preserved for several days may be sweet, there is the possibility of some product of bacterial growth causing you material discomfort.

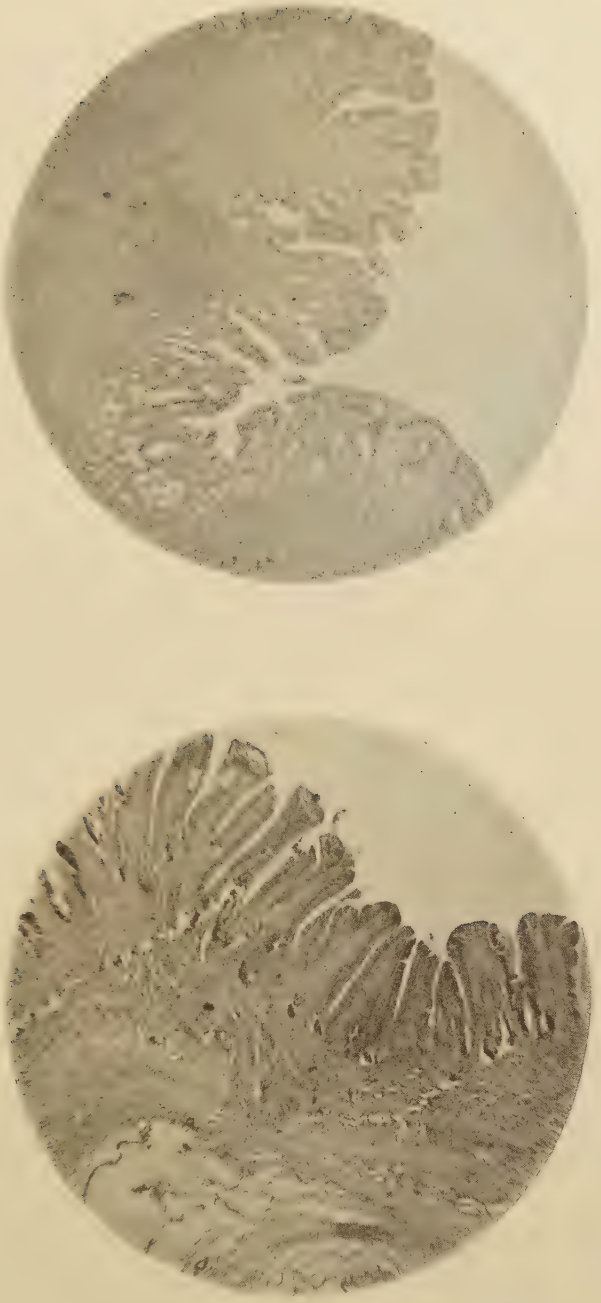
Gastro-intestinal Tract. To consider the digestive apparatus of the salmon from either an anatomical or physiological point of view, or from both, as one follows the other, would make very dry reading for the layman and lead him into a morass

of large names for small things where he would flounder without pleasure or profit. The subject, however, may be treated under a heading that is of interest to all salmon fishermen, and that is: Does the Salmon feed while in Fresh Water?

Until about 1880, the question of whether or not salmon fed in fresh water suffered in its consideration from what is known by psychologists as the anecdotal method of analysis. If it happened that a man found nothing in the stomach of an opened fish, he announced that the fish did not feed while in fresh water and were he sufficiently emphatic, his views were passed on, gaining disciples as they went. On the other hand, should a chap find a fly, sand eel or what not, he was firmly convinced that the river fish did feed and so gathered his little coterie of pros to wage wordy battle with the cons of his fellow dissector.

To strengthen their arguments, both pros and cons would describe several manners in which salmon had been seen by them to approach natural or artificial lures. One, though there were perhaps more, exceptions to this rule was Frank Buckland whose investigations led him to make plaster casts of the stomach and its connections, a kindly fishmonger permitting him to handle the fish before

GASTRIC MUCOSA (TISSUE REMOVED SEVERAL HOURS AFTER DEATH)
SHOWING STAGES OF POST-MORTEM DIGESTION



GASTRIC MUCOSA, NORMAL, FROM LIVE FISH

they were put on the London market. Buckland became so adept that he could carry on his work without disturbing a scale, but unfortunately he failed to arrive at any convincing conclusions.

From a purely scientific point of view, the matter appears to have been first approached by Fritsch and Miescher-Reusch of Germany, who studied salmon of the Elbe and the Rhine. When one has had the rudiments of pathology cut into him with the knife-edged tongue of an acrid German professor, it is more than passing strange to reflect on the failure of two products of the German school to recognize a post-mortem change of inevitable occurrence, in connection with which there is a favorite catch question in physiology.

Stranger still is the fact that some years later the same phenomenon should have been described as a normal physiological change by such men as Dr. Gulland and Dr. Paton of Edinburgh. With few exceptions, the Elbe and Rhine salmon were found by Fritsch and Miescher-Reusch to have gastro-intestinal tracts which contained no recognizable food remnants, but they did note in the stomachs a creamy, mucoid substance on whose nature they indulged in some speculation, not taking into consideration what should have been

immediately apparent, that it was post-mortem digestion of the lining membrane of the stomach. Evidently, both gentlemen had forgotten the golden rule of the old German autopsy room—that if you are able to recognize all the simple changes, the complicated ones will recognize you, a gentle admonition against being too keen on hunting abnormalities.

From Germany the scene shifted to the British Isles, where a Parliamentary grant made it possible for Dr. Gulland and Dr. Paton of Edinburgh to conduct extensive investigations on the salmon and its life history in fresh water. In 1898, these gentlemen published the fruits of their labors, and concluded that they had observed changes in the lining membranes of stomach and intestines, which made it impossible for salmon to take food in fresh water until about the time they had reached the kelt stage, and that these changes began as the fish approached the river mouths. They quoted Miescher-Reusch and were one with him in failing to realize that some things might happen in dead fish that would not occur in living.

After Dr. Gulland and Dr. Paton came Dr. Brown and Dr. Barton who proceeded to demonstrate to their own satisfaction, and it must be said

on rational grounds, that the former gentlemen had based their conclusions on false premises. Brown and Barton, however, were not altogether in accord, for Brown says that the fish do take food while in fresh water and Barton that they enter a period of physiological fast.

To add spice to the discussion, there was inducted by Dr. Paton the necessity of a definition of the term "feed," which he said should imply ingestion, digestion and assimilation of food and being nourished by the process. In consequence, it is small wonder that even so hardened a controversialist as Mr. Calderwood should in desperation ask what difference it made whether or not the fish fed while in fresh water, we should be sufficiently thankful that it came to a fly.

Thus the matter stands today, though in 1902 the medium through which the views of Dr. Gulland and Dr. Paton were most widely disseminated, the Annual Report of the Fisheries Board of Scotland, admitted that Dr. Gulland had erred through failure to allow for postmortem change in the tissue he had examined.

On the western continent, Pacific salmon have received more attention than their Atlantic brothers. This is particularly true of the United States

where the Atlantic salmon is practically extinct, but the Pacific fish is taken from the rivers and lakes of the Pacific States and Alaska in such vast quantities that according to Document No. 896 of the Bureau of Fisheries, the annual catch is sufficient to provide six pounds of nutritious food for every man, woman and child in the United States and its possessions.

So far as the author could find, Hamlin and Thacher, also Smith, made the only systematic attempts to study such a phase of the life of the Atlantic salmon from a scientific or semi-scientific point of view. The Report of the United States Fish Commission, printed in 1874, contains an account of their fruitless efforts in the market of Bangor, Maine, and at New Haven, Connecticut, where Thacher and Smith had salmon stomachs shipped to them for examination.

In periodicals devoted to field and stream affairs, there have been many articles by anglers but the vast majority concern themselves principally with the mechanics of fishing, which is also the slant of greatest import to American authors of books on sport. Few views on the habits of fishes, expressed in such articles and books, are the result of other than passing observations of casual behaviorists;

nearly all base their conclusions on preconceived ideas, and none penetrates far enough to reach the meat of the nut. In this we are the gainers, for had all pens that go salmon fishing devoted themselves to jotting down notes about why the big fish did not gobble a grasshopper, we should have lost many a page of sunshine, fresh air, and good fellowship, and reaped a crop of fireside Disko Troops who thought like the fish.

The actual taking of a salmon is such a simple thing that, unless one is possessed of a lust for killing, the capture of the fish contributes only a small part to the enjoyment of days on salmon rivers and the collection of agreeable memories for winter night reflections.

Unfortunately, the stress of business life sends most men to the boats with minds in which there is a subconscious current of anxiety too strong for them to derive much pleasure from the art of fly-tying, the perfection of casting, the delving into the life of the fish, or some angle of the sport to which one turns, when it is realized that after the fish is hooked, as much can be accomplished with a good reel and line on a respectable broomstick, as with the best rod ever wrapped.

Freedom from such care probably accounts for

the lengthy list of doctors and clergymen who have contributed to salmon literature, for possessing as a rule nothing but a saving grace of humor, and at times not even that, the meditations of a professional man are undisturbed by the prospect of his hide decorating the door of some neighbor's financial barn.

Being a poor caster and at fly-tying a veritable dub, the author turned to the phase of salmon life which his training had best fitted him to study, that of the feeding in fresh water, and in view of the fact that he killed and prepared his own material, he may be pardoned for parading a squad of observations collected through personal effort, alongside companies and regiments raised by means of government subsidies and university aid.

When the author took his first salmon in Nova Scotia, he opened it to see what it looked like inside and was surprised to find an empty stomach in what had appeared to be a feeding fish. As this sometimes occurs in trout, another salmon and then another was opened with the same result, much to the amusement of good Canadian friends who, in answer to questions, said that the fish did not feed while in fresh water. Why this was so, they did not know, but it was a matter of general knowledge

along the rivers, despite stories of salmon having been seen to leap at birds, squirrels, rats, and other small dwellers of the forest, to say nothing of one who attached himself to the tail of a swimming bear.

In the course of this first and long salmon fishing season, a variety of information was kindly given, but on only two points did every one seem to agree and those were that at times the fish will come to anything, but more often he can not be coaxed from his lurking place by fervid prayer or picturesque profanity, not to mention the futility of effort when you "lightly on the dimpled eddy fling the hippocritic fly's unruffled wing."

As soon as book shops and libraries were accessible, it was found that if a salmon fisherman wanted to learn anything about his fish, he would have to spend days in the public library, should he not be able to collect rare and expensive English books to get a fragment here and there, and that the question of salmon feeding in fresh water was one about which Scotchmen had been arguing for a century. Further, the widely accepted views of Miescher-Reusch, Gulland and Paton appeared on the surface to settle the feeding question once and for all.

There is a maxim in philosophy to the effect that one should be guided by accepted theory and demonstrated fact; there is also a maxim in pathology to the effect that demonstrated facts are more acceptable after one has been able to repeat the demonstration. So in preparing for the next season, a simple equipment for opening fish and preserving tissues was added to the usual impedimenta that are viewed with envy by your fellow travelers and resignation by your boatmen.

That the reader may better appreciate some of the difficulties of such study, it can be stated that the post-mortem change already alluded to begins so quickly that gastro-intestinal tissue for class demonstration should be secured from anesthetized animals before the moment of death. To approximate this, a fish must be banked and opened as soon as killed, such tissue as is required should be immediately snipped out and placed in preserving fluid and the offal wrapped in oiled paper and taken to camp to be burned.

The entire operation should be carried on well away from the water to prevent stream pollution and in a cleanly manner to avoid the possibility of scavenging birds transporting infectious material which may at any time be encountered. In regard

to these birds, usually crows, it is safe to assume that, as anthrax fed to buzzards cannot be recovered from their dejecta, less resistant bacteria are not spread by scavenging birds, except through the falling of dried particles of blood and flesh that have adhered to head, feathers and feet.

For equipment, a pair of forceps, scissors, knife, tape measure, bottles containing 10% solution of formaldehyde, a bucket, and some oiled paper napkins are all that are required. Though for convenience, there was added a cutting board, upon which the viscera could be placed for examination and which could be washed with formaldehyde after each operation.

There is much satisfaction but considerable labor attached to any investigation which involves the taking of your material in addition to its preparation; especially is this so when the taking involves a salmon, nor is the labor lessened by that winter geniality that leads us to promise many gifts of fish.

Were it possible to open every fish taken and study it as your conscience dictates, a large amount of data could be quickly obtained. But the task of propitiating two gods with offerings of so temperamental a fish as the salmon, makes division

a matter of necessity, rather than of choice, and most days when the fish are striking, you do not bank until auto-digestion is well on its way. However, it was possible to open 35 fish, the records of 21 being at hand and those of 14 lost during the shifts of 1917-1919,—and from these, ten cuts were made for laboratory study.

The fish were salmon and grilse taken about ten or twelve miles above tide water, but how long they had been in the rivers was a matter obviously impossible to conjecture with any degree of certainty, though all were bright and some had their sea lice still attached. The character of the food remnants and where they were found are indicated in the following table:—

No.	Sex	Fish	Weight	Character of Food Remnant	Where Found
1	F	Salmon	11½	Two fish scales	Stomach
2	M	Salmon	10½	Semi-solid gelatinous substance	Stomach
3	...	Grilse	4½	Fly wings	Lower gut
4	...	Grilse	4½	Fly wings	Lower gut
5	...	Grilse	5½	Nothing	
6	F	Salmon	11½	Fish scales	Stomach
7	...	Grilse	4½	Fly wings	Lower gut
8	...	Grilse	4½	Fly wings	Lower gut
9	M	Salmon	10½	Nothing	
10	...	Grilse	4½	Nothing	
11	...	Grilse	4	Several flies	Gullet
12	...	Grilse	4½	Nothing	
13	...	Grilse	5½	Fly wings	Lower gut

14	F	Salmon	15½	Nothing	
15	F	Salmon	15½	Nothing	
16	M	Salmon	7½	Fly wings	Lower gut
17	...	Salmon	8½	Nothing	
18	...	Salmon	6½	Vertebræ and ribs of small fish	Stomach
19	M	Salmon	7	Nothing	
20	F	Salmon	7	Nothing	
21	F	Salmon	8	Nothing	

Number of		Per Cent of	
Grilse opened	9	Grilse with food remnants..	60.6
Salmon opened	12	Salmon with food remnants.	41.6
Total fish opened ...	21	Fish with food remnants....	50.2

In the cuts which were examined after having been mounted in paraffin, sectioned and stained, there was no indication of Dr. Gulland's desquamative catarrh in any that were made from fish immediately after killing; nor was there any change to be accentuated by the strength of the preservative, to which attention has been called by Dr. Barton. Such as were made from two to twenty-four hours after death, showed post-mortem change ranging from partial to complete desquamation of the epithelial lining of the stomach, accompanied by degenerative changes in the mucous membrane of the intestinal tract.

So uniform were the food findings, that even the boatmen, at first skeptical, soon lost interest when it became apparent to them that in half the fish opened, could be found evidences of feeding if one

knew where to look for them and was able to recognize them when encountered. The tissue conditions were too ordinary for even passing mention, though had the fish been taken after a longer period in the rivers, there would no doubt have been manifest some atrophic changes incident to disuse which are mentioned by Brown.

Those of the non-feeding clan had the misfortune to take a side of the question that had for many years been warped by the popular opinion of a majority of the men connected with salmon fishing as sport or industry. With the empty stomach as a foundation for argument, their initial stand was strong, as no one attempted to give a rational explanation for such a state. To clinch the matter, Dr. Gulland and Dr. Paton presented what appeared to be indisputable evidence to the effect that it was a physiological impossibility for the fish's digestive apparatus to function during a prolonged period of its residence in fresh water. There have also been views advanced concerning the rapidity of digestion which some state is not an element to be considered, and concerning the powers of digestion which others believe to be exceedingly weak or practically nil.

At last, being on seemingly indisputable ground,

the non-feeders proceeded to garnish their opinions by giving additional reasons for the fish not feeding; one was that of the physiological fast, another that of stored energy. Some asked why the salmon should not indulge in such a fast, if it were possible for the stag to do so in mating season and other creatures at certain periods of the year, while others said that, as the fish entered fresh water with a large reserve supply of energy in fat and liver, he did not need food, so why should he take it.

To base conclusions on a small number of observations is not advisable, unless one can give a sound reason for so doing; to make the sweeping assertions of Barton even when partially or wholly correct, on the evidence presented by two or three fish is without the bounds of impersonal argument, as Dr. Gulland infers. The matter of salmon feeding while in fresh water, however, appears capable of such simple analysis that its demonstration quickly degenerates into a duplication of effort.

Dividing the subject into a few comprehensive parts which may be considered briefly and without intrusion of too much technical detail, it is possible to ask—first: Do the fish take food while in fresh water? Second: Why are not food remnants more frequently found in the gastro-intestinal

tracts of river fish? Third: Do the fish enter on a period of physiological fast when they come into the rivers? Assuming that the reader understands the kelt stage to be without the scope of this discussion, the questions may be treated as follows:—

First: That the fish takes food while in fresh water, we have the evidence of our own eyes in cases of 50% of those opened. To the given list could be added other examinations, the records of which were lost or not kept, but the average would remain the same. It may be said that these were fresh run fish and that such findings would not be possible in fish secured further up stream or later in the season, but it should be remembered that Gulland and Paton found nothing in their fresh run fish, while Brown discovered chemical evidences of food, sufficient to convince him that they took what they could get. On this particular phase, the character of the material searched by Fritsch, Miescher-Reusch, Hamlin, and Thacher and Smith was such that their opinions need hardly be considered.

Second: It is apparent upon even cursory dissection that the salmon body is one equipped with a very short digestive tract, that of a two-foot salmon being about two feet in length as com-

pared with the twenty-six feet or more of tube in a six-foot man. This tract when examined will be found to consist of a stomach with powerful muscular walls and firm, prominent, longitudinal corrugations on its internal surface, the two combining quickly to macerate and pass into the intestine any food stuffs that have reached the cavity of the stomach. Connecting with the first portion of the intestine are several highly complex tubes known as pyloric cœca, whose exact functions have not as yet been ascertained, but which are apparently very important elements in the exceedingly powerful digestive equipment. Communicating, also, with the first portion of the intestine is the duct which transports secretions from the gall bladder. The tract terminates in small intestine, large intestine and rectum, coupled to form a short tube whose peristaltic action is aided by the writhing motion of the body, peristalses in general terms being waves of rhythmical contractions, by which the intestines force along their contents.

Appreciating, then, the anatomical equipment and assuming the physiological demand, it is logical to conclude that the time must be exceedingly short between ingestion of a given food and dejection of its undigested parts, otherwise it would be

impossible for the fish to take and pass a sufficient amount of material to yield the energy for its immediate ocean needs and also build up those reserve stores of body and liver fat upon which its river existence depends. This rapidity of digestion is a matter of frequent observation when one removes from trout, small salmon fry with heads intact and tails macerated or digested, an illustration which is permissible, notwithstanding Barton's criticism of Gulland for using the trout for a parallel. It is further emphasized by the chemical findings of Brown, in the intestinal content, and not contradicted by the weak digestive power shown by Paton in extracts made from salmon stomachs, for reasons before stated.

That the fish do not get enough to keep them fat is too obvious for consideration but that they take, as Gathorne-Hardy says, the goods that God provides them, is evident. Such food as they are able to obtain is in small quantity, and of unaccustomed variety, and it passes so quickly that unless the fish is killed immediately after it has fed, and the examiner is equipped to make close optical or chemical search of the entire digestive tract, most evidences of feeding will pass unnoticed, as for example, fly wings or other small particles in

SECTION OF PYLORIC CÆCA
There are about half a dozen of these tubes.

the mass which is removed from the intestines. If such evidences of feeding are found twelve miles above tide water, in fish the length of whose river residence is problematic, there is no reasonable ground for assuming that they would not be found in fish taken in the upper reaches or in fish to the kelt stage, though it would, of course, be impossible to investigate such matters during the closed season.

Third: Aside from tissue changes and decrease of digestive power, there have been advanced, to support the theory of salmon entering on a period of physiological fast during part of their river life, the example of the stag in mating season and various other creatures during some times of the year. The writer does not know how much food a stag takes at such a time, but probably some readers can recall with pleasure having watched a bull elk circle his band of cows to protect them from the welcome advances of younger Romeos; if so, it will be remembered that the old bull, when not kept too busy, would snatch a quick lunch here and there. So even were he considered to have entered a period of fasting, it was one of reason and not of soul.

Other creatures that normally and voluntarily go

without food for long periods, are in a state of muscular rest, away from sight or smell of food, and either asleep or in a condition approximating coma. Of these, the bear which is our best example, emerges from his winter home a fat contrast to the slink salmon that slithers down the spring floods or the emaciated fish that finds its way back to the sea in the fall.

It is probable that the river salmon takes little food for the same reason that a St. Bernard dog makes a poor mouser, physical disqualification for and lack of knowledge of the style of hunting, and not because he is consumed by the emotion of his amours or aware that he is possessed of a large reserve stock of bodily energy. Fattening as he does on herring, shrimp or other sea creatures that swim in schools, he is accustomed to pursue a mass type of food that yields maximum value for minimum effort. On entering the rivers, he finds himself placed in a position where the size of his body makes it difficult for him to chase individual small fish and the fly and worm are forms of food to which he has been a stranger since the days of his early youth. The assumption that he takes flies and what not for food and not in a spirit of anger or play is in accord with "Lloyd Morgan's Canon"

that "In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one that stands lower in the psychological scale."

Having presented these evidences and ideas to prove that the fish feed while in fresh water, there remains to be discussed the possible bearing such taking of food may have on matters related to the salmon and its preservation. As a light upon the habits of the fish during his fresh water existence, the question is one of interest to naturalists, in that it is a link in the chain of study of a fish, about which comparatively little is known. To the angler, it affords material for his daily speculation upon the attractions of the artificial fly. So far as its bearing on the destruction of salmon fry is concerned, those in charge of river protection and river stocking need have no apprehension but, for reasons already explained, and not as some say, that in order to save the race from extinction, it has been ordained that the river salmon shall not feed.

Though it is known that the ova of intestinal worms are received by fish B from fish A, this in all probability does not take place through the eating of A by B, but from his having been in such a

position that the dejecta of A was swept down into the water that B was using for his oxygen supply. The condition of the fish in the Miramichi river during the season of 1915 was due, so the author has been told, to their having eaten diseased herring while off the coast, and that this is possible has been demonstrated by the experiments of Plehn.

In the Government publication which describes the Miramichi epidemic, there is mentioned a similar epidemic amongst the trout of the Nipigon during the same season and there is no reason to believe that both epidemics, if they may be so-called, were not the result of infection obtained from food stuffs, it having been shown that disease can be so transmitted. The matter is one for considerable thought and exceedingly difficult food experimentation by fish experts, upon whom we must depend to show us the quality and quantity of bacteria necessary for the several infections, if there be that number, and if our friend the salmon may acquire them through his occasional indulgence in fly, fry and trout.

Swim Bladder. In the centre and along the roof of the body cavity is a more or less well inflated sausage shaped sac, called the air or swim bladder.

Its position is adjusted with some mechanical nicety for the maintenance of buoyancy that is evidently one of the functions for which it was developed. The comparatively large organ found in salmon usually contains an appreciable amount of gas, composed of oxygen, nitrogen, and carbon dioxide given off by blood in the capillary vessels that line the bladder wall.

Connecting the bladder with the gullet is a small tube, the ductus pneumaticus, by which gas may escape from the bladder, and it is the forcing of gas through this tube that makes the salmon "sing" during the muscular contraction that follows death. The production of gas necessary for inflation is presumably controlled by impulses received through nerves of the sympathetic system and is, thus, not under the wilful control of the fish; deflation, however, in fish equipped with a ductus pneumaticus may be accomplished through voluntary muscular contraction, though whether this is done by the salmon it is impossible to say.

The exact functions of swim bladders in fish have long been a matter of speculation, especially as the bladder may be present in one branch and absent in another branch of a fish family that live under water and air conditions that are practically

the same. Its action as a float in such fish as possess it is generally conceded but there is a wide difference of opinion as to its manometric and barometric qualities, as well as to its relation to the ear and its partial control through impulses received from the ear by means of a bony chain called the Weberian ossicles.

The lack of knowledge concerning the sea life of the salmon precludes speculation on its use of the swim bladder, but in the lighter water of the rivers it must be of great assistance. The slow approach to fresh water should give ample time for bladder inflation and the presence of a ductus pneumaticus makes it possible rapidly to deflate on return to the sea, an arrangement admirably suited to the needs of an anadromous fish.

Other Organs. Into detail concerning other organs contained within the body cavity, it is hardly necessary to go, further than to say that the kidneys lie along the vault of the cavity and send their secretions into a small bladder, which is placed in front of and above the vent. The organs for production of milt and roe are both long and occupy the middle plane of the cavity. Concerning the eggs, it has been demonstrated by Kendall that in the salmon, they fall into a well defined membran-

ous trough, along which they roll to their point of exit at the vent, instead of dropping to the bottom of the abdominal cavity and rolling around in a haphazard way as had been previously supposed.

Brain and Nerves. It cannot be said that the salmon is particularly well equipped with those parts of the brain that are associated with powers of reasoning in the human brain, nor can he be classed amongst the fish intellectuals on brain development alone, as his is considered a primitive type. There are given off from the brain, ten cranial nerves and as is usual in vertebrates, fibres from the brain continue into the spinal cord.

The large pituitary gland connected with the salmon brain makes the fish an object of grave suspicion on the part of a coterie of medical men who are now attributing most ills to disturbances of the functions of the ductless glands. From their point of view, the salmon may become an imaginative, suspicious, fanciful fish if their particular gland deviates from the normal in its secretion.

The lateral line organs of which one reads are nerve buds that dot the sides of the fish and receive impulses for transmission to the central nervous system. Parker has found on experimenting with dogfish, skates, etc., that these organs

were capable of being stimulated by water vibrations of intensity as low as six per second. He does not think that they are influenced by heat, light, salinity of water, or water pressure. Parker believes that they may be of service to the fish in orientation and others think they are of much value in assisting fish, particularly the blind species, to avoid objects such as stones, reefs, banks, and walls, by their capacity for appreciating undulatory movements of reflex waves from nearby surfaces.

Eye. Eyes such as those possessed by the salmon differ from human eyes in several respects. The human has what is called binocular vision and sees practically all objects with both eyes, while the salmon from the position of his eyes must look to the right with one eye and to the left with the other. Though he may be capable of a certain degree of binocular vision for objects at a distance in front, above, below, and behind, the range and utility of his binocular vision are probably very limited.

The eye is lidless and its lens is almost round, so that the magnifying powers will be sufficiently great for the appreciation of objects seen through a medium the density of water. In adjusting itself to changing conditions of light, clarity of water,

and proximity and size of object, the lens accommodates by having the distance between it and the cornea increased or diminished through the action of a small retractor muscle, and not as in the human, by variation of lens convexity.*

There have been numerous tank experiments conducted with a view to ascertaining the visual range of fish, their color sense, and their ability to recognize food objects. Most of these experiments were with fish distantly removed from the salmon or its family. One that was carried out in much detail, recorded the picture received by the human eye gazing through a tank at an artificial fly being dragged across the water surface.

It is, of course, true that much valuable information can be gained from observation of the conduct of wild animals or other wild things when they are in a state of captivity, but the practical value of such observations as applied to the animal in its natural habitat is often very questionable. This is particularly true of fish, for it is not within

* A camera is placed "in focus" by adjusting the distance between the image and the lens, the one being movable and the other fixed. In the human eye, the same effect is accomplished by a different method, i.e., by changing the convexity of the lens, thus varying the distance between the lens and the retina or image. In the case of the salmon, however, we have the exact counterpart of the camera process for the retina is stationary while the lens (too indurated to change its convexity as in the human eye) becomes movable through the medium of the retractor muscle.

human power even to remotely approximate by means of tanks and running water, those conditions under which a game fish lives.

The hundredth generation of tank-bred goldfish, worthless brutes like dogfish, or small catfish, appear to lend themselves to such experimentation and for that reason, they are usually chosen. However, one could scarcely expect a salmon, trout, or bass to learn a goldfish maze or discriminate between bags of different colors that might be dangled before them by the savants who are fortunate enough to be of the elect that gather each year at Woods Hole. Trout are said to avoid attempting to reach screened food after a few futile attempts, but the visual range of game fish and their appreciation of form and color are largely matters of speculation.*

* That a fish in captivity may be trained to perceive or recognize a color does not by any means prove that the same fish in its native environment would possess a similar faculty. Even physical laws usually operate perfectly only under perfect conditions and perfect conditions do not often occur in nature. For instance, there has been much experimentation of late concerning the radius of vision of a fish in the water and the visible area both in the water and above the surface. It is elementary that all objects above *an unruffled surface* are not within the compass of the submerged eye on account of the total reflection which occurs at an angle of about 43½°. In other words the fish looks out upon the world through a conical telescope or funnel with its apex at the eye and its circular orifice increasing in size with the depth of the water. With equal precision may be computed the height above the unruffled surface at which objects on the bank or elsewhere may be visible to the fish through this conical aperture and interesting deductions may be drawn such as the inability of a fish to

Ear. Boatmen say that some fishermen are so impressed with the possible effect of noise on salmon that they become peevish if a man even shifts his quid. This knowledge weighs no less heavily than the doubt which some investigators experience concerning the ability of the fish to hear at all. Structurally, the ear of the salmon is adapted to central control of equilibrium, rather than to the appreciation of sound, as is indicated by development of such parts as are connected with maintenance of balance at the expense of those associated with the reception and analysis of sound waves. A number of methods have been used to determine, if possible, the hearing power of fish, and the conclusions arrived at have been as numerous as the methods used for testing.

For many years, it was assumed that the ability of fish to hear, was clearly demonstrated by the action of carp in the pond of a Belgian Monastery. These carp came for food on the ringing of a bell and were a source of revenue to their clerical owners and local guides, until some prying individual found that they did not respond to the bell when

see a floating fly in shoal water until it is almost directly over it. But all of these conclusions presuppose a perfect, glassy, reflecting surface and such a surface occurs with the greatest rarity in nature and almost never in salmon rivers.

its ringer was out of sight, but would appear when a figure approached the bank with or without bell ringing. Bells suspended over tanks have been struck, bass viol strings strummed, whistles blown, stones clicked above and below the water surface and guns fired to test the appreciation of sound as manifested by change of position or increase in gill or fin motion. A Frenchman even had himself lowered in a diving suit that he might better observe the response of a school of small fish to spoken words.

But there remains a difference of opinion as to how great, if any, perception exists for the appreciation of sound as the meaning of the word is generally understood. With weakfish Parker has demonstrated sound perception to his satisfaction, while, on the other hand, Bernouilli got no response to bells and pipes when tested on trout in open streams and under natural conditions, so he concludes that fish do not hear, but respond tactually or visually when at all, to the mechanical motion in water. The control of balance has been well demonstrated by Parker through removal of one, two or three of the semi-circular canals, following which the fish will go down by the head,

down by the tail or turn belly up and lose interest in his position.

Nose. Two small depressions or pits represent a salmon's nostrils and they are placed between the eyes and the anterior margin of the upper jaw, one on either side of the median line. In the fish, these pits are dotted with nerve bulbs and have nerve connections whose capacity for the appreciation of scent is developed according to the needs of the fish.

Some biologists hold that as odor is rapidly dissipated in water, the fish has little use for a sense of smell but others maintain that scent bearing particles are borne down by the current and coming in contact with the nostrils of the fish, lead it to food. In that classification of fishes which divides them into those that hunt with the nose, and those that hunt with the eye, salmon are placed in the latter division. Probably salmon do possess some slight ability to appreciate odor but demonstration of that fact, as well as many others connected with the special senses, remains for those who study the fish

"Taking therein no little delectation
To think how strange, how wonderful they be."

CHAPTER IV

DISEASE

From time to time, there are cast up on the beaches or there float on the water surfaces many dead fish, and there are years when a high mortality is observed amongst the fish of this stream or that. The disease, diseases, or whatever kills these fish may be confined to one species or affect several. If sewage or other stream pollution is the causative agent or when there is a direct connection with mine firing or under-water blasting, the appearance of dead fish on water surface or shore is easily accounted for, but the character of most disease remains unsolved.

Were it possible to determine the nature and cause of fish disease by merely inspecting a dead fish, many stones would be removed from the paths of those engaged in fish culture; however, according to Koch's postulates which are guiding rules, in order to prove that an organism or agent is the causative factor in a given disease, it must always be found associated with that disease and must pro-

duce the disease when injected into a healthy animal.

In thinking over the obstacles which confront a fish pathologist, the author is always reminded of a bright suggestion he made years ago when attempting to solve some of the difficulties of night turkey shooting, and of the pertinent comment of a fellow nimrod. Phosphorus on the gun sight was proposed and met with general approval, until the chronic objector remarked that it would do little good unless the turkeys could be treated in a similar manner.

The man who investigates fish disease may isolate bacteria of many sorts from the bodies of sick and dead fish, but to produce disease in healthy fish by the injection of these bacteria is quite another matter. Tank conditions are far from satisfactory as one never knows when his fish is suffering from confinement, and if such work is attempted by the stream side and remote from the complicated equipment of a laboratory, the task is almost impossible. Again, if study concerns diseases that are attributed to agents which are received by mouth, success depends on feeding experiments and the investigator is entirely at the mercy of the whims of the fish,

for some will not feed at all and none takes kindly to food forced down the gullet.

The limited scope of our knowledge concerning diseases of fishes is indicated by the comparatively few articles on the subject that have appeared in scientific publications and the lone German text-book, published nearly twenty years ago, which occupies a place of honor in all bibliographies. For the present purpose this is fortunate as the lay public is interested only in the ills and isms of man and has little regard for those of fish.

To simplify description and for a chapter of this character, the conditions and things which may or do affect the health of salmon can be divided into:—

Tumors,
Diseases of Bacterial Origin,
Diseases of Unknown Origin,
Internal Parasites,
External Parasites.

Tumors. That malignant growths are foreign to lower animals is the negative idea of minds too fully occupied with consideration of the ravages of cancer in the human family, to associate such conditions with creatures lower in the vertebrate scale. In consequence, the average person is sur-

prised to learn that canary birds have sarcoma and fish have carcinoma, both of these growths being included in the general definition of the term cancer.

The type of tumor which so frequently occurs in fish hatcheries is the one called carcinoma or, to sacrifice scientific accuracy for descriptive emphasis, true cancer.

It is known by various names as "Gill disease," "Thyroid tumor," "Endemic goitre," "So-called carcinoma of fish," etc., and most frequently attacks the brook trout fingerlings in hatchery tanks, other varieties of hatchery trout with less frequency, and is seldom found in free fish, Dr. Gaylord's monograph mentioning but one instance of such growth in the free Atlantic salmon.

When the growth occurs, the first ocular manifestation of its presence is given by the appearance of a reddened area in the floor of the mouth, as the cells from which the tumor springs rest principally in that locality, above the main artery and between the first and second gill-arches. If unchecked, the mass increases in size until the mouth is filled and the gill-spaces occluded; there may also be metastases, or wandering of cancer cells to different parts of the body where they produce secondary growths.

The etiology of the condition can apparently be traced to certain food deficiencies which promote a hyperplasia or abnormally rapid proliferation of the thyroid cells. In the very interesting monograph which Dr. Gaylord has written, it is indicated that the disease can also be transmitted and that it may be controlled by change of food and addition of iodine to the water. There is a pronounced thyroid enlargement in dogs who are given water containing tank scrapings.

Diseases of Bacterial Origin. Eye. A condition affecting the eyes of codfish was studied by Dr. Bergman of Stockholm whose attention was called to its existence amongst cod off the West coast of Sweden, that portion bordering on the Ore Sund, in the year 1910. As is frequently the case, this disease had been noticed by fishermen for some time before news of its presence percolated through official channels and reached Dr. Bergman and as a result, he was able to secure only three specimens. The disease called by Dr. Bergman "Keratomalacia" usually affects both eyes and varies in severity from a film-like membrane covering the eye-ball, to destruction of the cornea and falling out of the lens. He attributed it to a type of microscopic organism called the vibrion.

Tuberculosis. Some years ago, Dubard-Bataillon-Terre secured from a tumor-like mass found in a pond carp, an acid-fast bacillus (one from which certain aniline dyes cannot be removed by application of acid) that resembles the bacillus which causes tuberculosis in man, and it received the name "Fish tubercle bacillus." The discovery aroused great interest as at that time the Continental laboratories were working under pressure in attempts to find some means of utilizing the tubercle bacillus, or its products, in combatting the disease for which it is responsible. Though it was perhaps a questionable addition to the group of human, bovine and chicken tubercle bacilli, it was nevertheless, experimented with and the other forms were tried on fish. However, the bacteria were found to be of no particular importance as a cause of fish disease, nor could they be made to serve a useful purpose for the human.

Yolk Sac. "Hydrocele embryonalis" so called by L. Betegh in 1912 attacks trout fingerlings of the hatchery tanks and causes great mortality, as it appears in epidemic form. "Bacillus liquefaciens piscium," according to Betegh, is the evil organism responsible for this trouble which kills the newly hatched trout in two days. The fish

seemingly well, are noticed with yolk sacs slightly enlarged, the enlargement increases as fluid accumulates in the sacs and the fish weighted down sink to the bottom of the tanks and die.

"Tympanitis embryonalis." "Tympanitis embryonalis," a disease of unknown, but supposed bacterial origin, affects the same class of fish and according to Betegh, follows Hydrocele embryonalis in the hatcheries. Some little fish have both at the same time but as either is sufficient to kill, there is seldom opportunity for one to be superimposed on the other. In Tympanitis embryonalis the abdomen of the fish swells out like a drum and finally bursts or flattens and the fish sinks to the bottom and dies.

Furunculosis. "Furunculosis of the salmonidæ" is a name given to a condition which manifests itself from time to time in tank, brook, or river trout by the formation of underskin abscesses varying in size from a pin head to that of a silver dollar. The disease is supposed to be incident to water pollution and can be produced in healthy fish by feeding them on food containing "Bacterium salmoncidia" which have been recovered from pus or blood of the diseased.

Salmon Disease. The best known and most

generally dreaded of all ills that affect the salmon is what is called the "salmon disease." This condition kills many hundreds of fish in Scotland and England and has claimed the attention of fish culturists and owners for a number of years. It has been extensively studied, some articles on the subject dating more than thirty years back, and has been serious enough to claim Parliamentary attention.

As is usual in study of cause of disease, the obvious received first attention and in this instance, it happened to be a fungus, the Saprolegnia ferax. This easily seen fungus grows in patches of greater or less size on the body of the fish, and if the individual possesses sufficient resistance and does not return to salt water, it will eventually cover his body and invade the gill clefts, thus interfering with respiration and killing him by suffocation.

Through the efforts of Patterson, it has been proved that the growth of Saprolegnia ferax can only occur on surfaces that have been prepared for it by the action of Bacillus salmonis pestis and that these bacilli do not affect the unbroken skin, but begin their growth in bruised or lacerated tissue. As the fish comes up the river with stone bruise or net mark, he receives his infection from water in

which some fish has died or through contact with an infected fish. Bacillus salmonis pestis prepares the bruised spot or net mark for the growth of Saprolegnia ferax, particles of which are always floating in the vicinity of other diseased fish. The irritation from bacteria and fungus causes the fish to rub himself against the rocks or on the sandy bottom and prepare more surface for infection. So it continues, until the gill clefts are invaded by fungus and the fish may be seen swimming wildly around the pools, leaping in an aimless fashion, and dashing himself against the stones in paroxysms of air hunger until death mercifully intervenes.

Saprolegnia ferax is killed by salt water, so it is possible for the fish to free himself of that element of his affliction by return to the sea. Bacillus salmonis pestis, however, flourishes in salt as well as fresh water and presumably remains with the fish until his death. Patterson strongly recommends that no dead fish be buried as there is always the probability of their being washed up and their bacteria carried into the stream. He advises that such fish as are found dead be burned, and to this may be added, that those seen to be infected should be captured and burned with due care toward

handling, in such a manner that it will be possible to sterilize all things which come into contact with the fish.

Those who have the interests of the salmon at heart and especially those who own salmon water are advised to bear in mind the terrific possibilities of this disease and see that such dead or sick fish as they may find be immediately secured, doubly iced in a *tight box* and forwarded without delay to the proper authorities, from whom instruction will be received as to what measures should be taken to combat recognizable epidemics.

Diseases of Unknown Origin. Of these most escape notice as has been observed at the beginning of the present chapter. There are, however, exceptions to the rule and in Sessional Paper No. 58 a, issued at Ottawa in 1918, is an excellent account of an epidemic that appeared amongst salmon at the mouth of the Miramichi River in the season of 1915. It is described as follows: "The disease takes the form of a fungus. The first indication is the removal of the scales from the back of the neck. They are evidently eaten off. Then a white fungus develops, which rapidly spreads down the head to the eyes and makes the fish blind. It subsequently appears on different parts of the body and on the

extremities of the fins and tail. The diseased fish were beginning to die, which indicates that they will not last more than a week or ten days after they become affected . . . a disease apparently of a similar nature, has broken out amongst salmon trout in the Nipigon River. . . ."

Dr. Harrison, who investigated the Miramichi epidemic, very naturally tried to connect it with the well known "salmon disease." But disappointment is the daily bread of the laboratory man, and Dr. Harrison was not successful despite the fine quality of his work. As was said before, the author has been told that this epidemic was eventually attributed to the salmon having eaten diseased herring while off the coast; what cause was presumed responsible for the Nipigon epidemic does not appear.

During the summer of 1919 dead salmon began to appear in the Restigouche. The actions of these fish before death were closely observed by one of the gentlemen who fishes that river and the account which he gave follows that of fish affected with "salmon disease." No fungus was found on the fish and they were free from outward manifestations of disease so far as can be learned. There were, however, holes eaten in the gills and to the

OFF FOR THE DAY, ON THE UPSALQUITCH, NEW BRUNSWICK

gills were attached parasites whose position and size suggested their being the responsible agents.

Some of the parasites were sent to Dr. Chas. B. Wilson for identification. He pronounced them parasitic copepods of a species known as Salmincola salmonia (Gissler) and said, "It is common on salmon in England, but I think these are the first specimens from the American continent. The data given you was correct, except that the parasites did not eat any of the gill tissue. Their mouth parts are fitted for *sucking* like those of a moth or butterfly. They pierce the gill filaments and suck the fish's blood, but of course could not do any eating. . . . In some of our fish hatcheries they sometimes appear in sufficient numbers to kill hundreds of the small fry. This might possibly occur on the salmon, but is not at all probable. I have taken more than 50 specimens from the gills of a half pound brook trout that was apparently perfectly healthy. These were another species of the same genus, Salmincola edwardsii, but were more than half the size of the ones you sent. Something else must have killed the salmon."

Internal Parasites. A man is never a hero to his valet nor is a salmon ever free from repulsive features to the one who cleans him. From teeth to

tail he may be a veritable worm case, as many as 33 species having been found in the Atlantic type of fish. The most common form seen in western waters is a slender tapeworm usually abundant in the small intestine and recognized without difficulty. Its presence apparently causes its host no inconvenience nor are the eggs of it or any of its fellows considered of more than remote danger to humans in this latitude.

External Parasites. In addition to the copepod mentioned in the description of the Restigouche epidemic of 1919, there is the sea louse familiar to all salmon fishermen. These crab-like creatures insert their blood sucking apparatus beneath the scales and remain attached an indefinite time in the ocean and for four or five days after the fish comes into fresh water. It is questionable whether or not they are as harmless as usually supposed, for it would seem that the inflamed areas of their attachments might be fruitful soil for growth of bacillus salmonis pestis. As carriers of infection, mere passing knowledge of their prototype the tick suggests such possibilities, that it requires no great flight of imagination to picture goggle-eyed scientists of the future, transferring

their hunts from offspring of the tick on meadow grass, to crab-like sea lice in

> "The raging sea beneath the valley low,
> Where lakes and rills and rivulets do flow."

CHAPTER V

HABITS

PERHAPS like Kotik a salmon spends his ocean days in search of beaches inaccessible to man, or as some think, he may follow schools of shrimp that linger near the icebergs; we only know that in an undertermined place he stays, fattens and matures.

Our scientific friends tell us that wise nature directs the fish to fresh water because eggs and milt are destroyed if cast in brackish tide or stronger brine, so when in from three to ten years the salmon gathers sufficient courage to stamp its image on a modern child, it moves toward shore and perils new and greater than any of the sea.

With many of its kind in what is called a run, it comes direct or coasts along until it reaches familiar bay or river mouth, when begins a journey through a net strewn way that takes tremendous toll of those who fail to strike the narrow lane of clear water or have insufficient strength to pierce the meshes of the nets. If fortune favors, it wins

through, usually net scarred, to the water of a river upon whose surface float many aged gentlemen casting tinseled lures, and innocent looking scows from which may dangle meat-embedded hooks.

Back swim the runs or schools of salmon in the different months of spring and summer to different streams; the large fish of the main streams as is customary with dignitaries, arrive first, while the little fish or crumbs for Lazarus of the small streams are last. The earliest runs proceed as far up as the water permits, the next stop lower down, and so the filling of a stream continues until each gravel bed has its quota of fish anticipating parenthood.

When comfortably settled near the banks of their choice, they pair off, selecting mates at random, and enter on a short but stormy period of married life. During the early months of the following spring, as evidence of the industry of the parent fish, there wriggle from between the bits of gravel of the spawning beds millions of alevins to begin the first of the five ages of salmon.

Discussion of the habits of salmon is bound to give rise to controversy, whether one permits one's self to wander along the pleasant but inaccurate

paths of anecdote and river bank observation, or is content to draw conclusions from controlled experiment. In the estimation of Walton, a good angler should be a sort of mental Admirable Crichton, poetical, philosophical, musical and religious, able to sing or write about his favorite pastime or indulge in gentle discourse on all matters related to fish and fishing. But fortune is not so lavish in her allotment of accomplishments and while there are many anglers who write and sing agreeably, only a few seem capable of quiet argument, for as Calderwood says, "The heat and intolerance which have been exhibited in Scotland at least, over disputes about salmon, almost rivals the spirit shown in recent times over church distinctions."

In fact a meeting between men who know all things that salmon do and why, reminds one of the mountain boy's essay on wild cats. "Wile cats is quick and hard fitin critters. I seen two wile cats come together an they fit, an they fit, an they fit until they fit clean up out of sight. When I went by next day, the fur was still a fallin." Some reasons for the acrimony displayed by men in such discussions are perhaps not far to seek as it cannot be denied that the majority of anglers are prone to exaggerate and almost every one wishes to be con-

sidered a clever observer, so with appreciation of a collective failing and assumption of a common desire, the result of their meeting is foreshadowed by the challenge of their approach.

Rabbinical law decrees that those who play with flying doves are disqualified to be witnesses and though it is a far cry from the Plains of Jericho to the Highlands of Scotland, we receive a similar warning from Calderwood in regard to those who play with leaping fish. To say that we should not accept observations regarding the habits of salmon from anglers and river men seems a harsh admonition until analyzed, but a moment's reflection brings one to appreciation of the fact that most stories from such sources are based on boat and river bank estimation of time or distance or fish reasoning.

It is unnecessary to emphasize the difficulty of measuring time and distance without instrumental aid, particularly when view of the object concerned is confined, as a rule, to a flash in the air or intermittent glimpses at unknown angles through a medium of unknown density and unknown depth, nor does it seem essential to dwell on the danger of assuming the fish to exercise a mental function for which it is negligibly equipped.

Furthermore, only questionable values are contained in ideas formed by the method of anecdote which is consideration of detached incidents. It is hence, necessary to turn for satisfactory information to scientists and fishery officials who coordinate their ideas and change them, as their own and the controlled experiments and carefully formulated opinions of their fellows dictate; but in doing so, one must remember that most pages of the several chaptered life of salmon remain uncut, and that many opinions concerning their habits are attempts to build plausible theories on a very slender foundation of demonstrated fact.

Two primary problems which confront those connected with the fisheries are the encouragement of natural and development of artificial propagation. The first of these is a matter of protection while the second is approached with the biological certainty that as like usually breeds like, it is possible to liberate the progeny of almost any strain of fish in any stream.

To the average person, it would seem that fish culture must be confined to production of as many as possible of fish of a given family. The art, however, is not so simple for it involves breeding of selected strains to meet the physical and sea-

sonal requirements of streams or to increase the size and numbers of existing stocks. That this may be accomplished, the brood fish are picked for size and health from official or private nets, by men so familiar with salmon that they can stand on the bank of a pound and name you the parent streams of those local fish who exhibit distinctive head or body features or some special shade of color. As desired, the fish may be taken from any of the several runs which are designated according to season, as early spring, late spring, early summer, etc., and are then kept in pounds until ready for stripping in late September or October.

When the fish are considered ripe, they are scooped out of the pound and given to the stripper who, holding the fish's shoulders between his legs, steadies the tail with his left hand and compresses the belly with his right to force milt or roe from the vent into a waiting pail, an operation facilitated on the Pacific side by merely slitting the fish open, as Pacific salmon invariably die after spawning. Eggs and milt thus secured are mixed and the mixture allowed to stand for 2-3 hours in water until the eggs harden, after which they are placed in troughs of the nearest hatchery until the appearance of the germinal spot, at which time they are

said to be eyed and are ready for transportation to other hatcheries.

Alevin. (Derivation: French alevin, according to Littre for alevain from Old French alever, to rear. 1. Latin, adlevare, from ad to, and levare, to raise; like nourrain from nourrir.) This larval form of salmon life emerges from the egg, as has been before stated, in from 90-150 days according to the temperature, the colder the water the longer the period of incubation, and they are so small that Prof. Prince, from whose report the above statement was obtained, found that it took nearly 255 to make up an ounce. (In the fish troughs are nearly always seen a number of two-headed or two-tailed alevins whose formation arouses curiosity and discussion. The appearance of these monsters whose life is short has been satisfactorily explained by Dr. Southard, as the result of a splitting of the germinal cells which may occur when the oxygen content of the trough or tank water is reduced, as by lowering the temperature.)

Alevins after a short time in the troughs are placed in tanks until their yolk sacs have almost entirely disappeared, a process requiring from 4-6 weeks, and they are then liberated. The fish which have been naturally bred and break out from their

egg shells into river water lead an uncomplicated life, being rolled by the current from one crevice to another until they are strong enough to make a little headway, when instinct teaches them to keep as much as possible in the shelter of the stones. As their size increases and their yolk sacs disappear, they begin to experiment with the nutritious properties of such organic matter as they can crowd into their small mouths, and prepare to enter the second or parr stage of salmon life.

Parr. (Parr, also Par: Apparently of Scottish origin; derivation unknown. But it may be a variation of par, to inclose.) When the yolk sac has disappeared there develop on the sides of the body a series of black bars or parr marks. These marks cross the lateral line at right angles and have between them numerous brilliant red spots which enhance the beauty of an already beautiful fish, and both marks and spots remain until the fish becomes a silvery smolt and goes down to the sea.

From the moment of stripping until the liberation of alevin or parr, the fish culturist and his biological colleague have had their problem well in hand but with the slipping of the fish into river water, begin the actual and often insurmountable difficulties of its study. What the parr eats and

what eats it are matters of comparatively little importance as it concerns itself with worms, flies, etc., and is in turn preyed upon by cannibalistic fish and piscivorous birds, but the length of its river life and its development of characteristics bear intimately upon the establishment and maintenance of fisheries. Thanks to the practice of marking fish and to the perfection of scale reading, such phases of the fish's life can now be examined with a greater degree of accuracy than was before possible.

As the author has been unable to find any marking or scale reading statistics that relate to salmon of the western Atlantic, it has been necessary to consult those compiled in Scotland, England and Norway, for data which might possibly apply to the fish of our streams.* Mr. Hutton, by

* From Annual Report on Fish Culture, 1921, Dept. of Marine and Fisheries, Fisheries Branch, Ottawa, 1922.

MARKING OF SALMON AND TROUT.

Up to December 31 the recapture of 152 Atlantic salmon out of a total of 4626 that were marked at all the ponds from 1913 to 1920 inclusive, by numbered silver tags attached to their dorsal fins when they were stripped and liberated was reported to the Department; 48 were recaptured before they had left the rivers and 104 after their return from the sea. No particulars were furnished with one tag beyond the statement that the fish from which it was procured was caught at Dee Side in the Restigouche in 1920. As this tag was attached to the salmon in the Kedgwick river in October, 1919, it had likely not been to sea before it was recaptured, and in the absence of definite information is being regarded as a kelt. Of the 104 clean fish 23 were recaptured in the first, 78 in the second and 3 in the fourth year after they were marked. The recaptures of clean fish that were marked at the Tadoussac, New Mills, Kedgwick river and St. John were 13, 8, 5, and 13, respectively. All those fish were

examination of scales of 466 fish from the river Wye, found that 3.15% spent one winter in the river; 91.7% two winters; and 5.15% three win-

of the early run the year they were marked, as well as the year they were recaptured. As the hatchery net in the York river was fished through the spring and summer there is no record as to the run to which the two recaptures in that district belonged the year they were marked, but one was recaptured in the hatchery net on September 10 and the other in a commercial net in the outer harbour at Gaspé on July 19. The single recapture reported from the Morell river was caught after October 24 when it was marked in 1919 and was recaptured in August, 1921. The 21 recaptures from the Miramichi river were originally caught and marked after September 15. Three were recaptured in June, 6 in July, 3 in August before the close of the net-fishing on the 15th, 1 on August 31, and 8 in hatchery nets after September 15. The 41 recaptures of clean fish from the Margaree were originally caught and marked after August 25. 11 were recaptured in June, 15 in July, 7 in August before the close of the net-fishing season on August 15, 1 on August 27, 1 September 4, 1 September 18, 3 in the hatchery net, which is set about August 25, and 2 at uncertain dates before August 15.

The Miramichi and Margaree salmon were originally caught in the late summer and early autumn after September 15 and August 25 respectively in the nets operated for hatchery purposes. 62 of these fish that were marked and liberated in these rivers were recaptured. Of this number 47, or a little over 75%, were caught in the spring and early summer before August 15, and only 15, or nearly 25%, were caught after that date.

These recaptures, while limited in number, indicate that the spring and autumn fish do not comprise two races of salmon and that heredity is not the predominating influence in regard to the season or month at which salmon ascend our eastern rivers, but, on the contrary, autumn salmon of any year is likely to be a spring or early summer fish when it again returns to fresh water.

In all the years previous to 1921, only 5 salmon, all marked at the Margaree pond, were recaptured at any distance from their home stream; viz., 3 at different points on the Newfoundland coast, 1 at Ingonish and 1 at Aspy bay, on the easterly side of Cape Breton Island.

In 1921 recaptures were reported as follows, viz., One marked in the Kedgwick river in October, 1919, was recaptured in Placentia bay, Newfoundland, in June; one marked at South Esk in the Miramichi river in October, 1920, was recaptured at Bonne Esperance, Newfoundland, in July; of 3 marked in the Margaree river, one, in November, 1919, was recaptured at Merigomish, and, of the other two, marked in November, 1920, one was recaptured at Stephenville, Newfoundland, in June, and the other at Flowers cove, Newfoundland, in July.

ters. Dr. Dahl has concluded that the further north the river, the longer parr remain, for Norwegian fish average three winters in the rivers and in extreme cases remain six before going to the sea. Prof. Prince of Canada is or was of the opinion that the parr of this continent descend as smolts after one or two years, or twenty months of river life. The excellent article in which Prof. Prince's statement was made, appeared in 1912 and quoted a previous report of 1885, before the value of scale reading had been fully developed and such matters could be determined with the assurance that now exists; it is, however, in all probability correct.

That salmon return for spawning to the rivers in which they were bred is a common belief in this country, as it has been for many years in Scotland and England. In the latter countries by means of marking, it has been demonstrated that many do return, though the percentage of the fish captured to the number marked is small.

The views of Dr. Dahl, somewhat in opposition to those of his fellow countryman, Landmark, are entirely rational, as he thinks there is no hard and fast rule and that many fish spawn in rivers other than those in which they were bred.

It is undoubtedly true that a vast number do return, for strain differences are sufficiently pronounced, in this country at least, to make identification easy; furthermore, there is the indisputable evidence offered through the restocking of barren rivers. This urge, or whatever makes so many fish seek their parent streams, is commonly called the "homing instinct of salmon" and is variously explained as being due to a desire to return to those fresh water conditions known in youth, such as chemical composition of the water of a given stream and its temperature, or adaptability of the body to the physical features of a certain river, etc., and one or all of the several explanations may be intimately connected with or entirely remote from the actual reason.

If instinct is a controlling factor, it can be inherited, inherited and acquired, or acquired, though possibility of the former is purely an assumption, while existence of the latter two forms of instinct is considered on the grounds that fish bred naturally return to their parent streams and fish bred artificially return to the streams in which they were loosed as parr.

The relative predominance of inherited or acquired instinct, in relation to the return of salmon

to home streams, should be in a measure determined by the action of those who, as parr, were raised in ponds and not subjected to stream influence. This would, of course, necessitate the taking of large numbers of marked fish, for the capture of a few who might be casual strays, would hardly furnish convincing evidence, as Canadian officials recognize, in not becoming excited over the appearance of two or three adult Pacific salmon in sluices leading to ponds wherein they had fattened on delicacies of the piscatorial nursery.

Body adaptability to stream conditions is a theory recently advanced on the Pacific coast, though it has for many years suggested itself on the Atlantic side where types of streams and types of fish are perhaps more intimately observed. The theory may apply within certain limits to the Atlantic salmon but it does not entirely satisfy. For, while very large fish do not of course fit very small rivers and are seldom seen there, the medium sized fish has no compunction about continuing up a main stream if, after lingering around the mouth of his parent river for several days, he does not find the water to his liking. It is reasonable to believe that be what the influence may, it is developed during parr years of the fish's life, as he virtually

leaves his river at the end of the parr period and does not know fresh water again until he seeks the same river for his grilse or spawning life.

The growth of parr during their twelve, twenty-four or thirty-six months is a matter of a few centimeters of length and a few grammes of weight. In the streams of this country, those most frequently seen are so uniform in size that they remind one of the like parts for assembled engines, until their slight differences are ascertained by weighing and measuring. Pond-fed parr gain weight more rapidly and are said to return from the sea as salmon or grilse a year earlier than those loosed in the stream. If such is habitually the case, the economic value of so handling young salmon will be material, provided the cost of feeding and care is not too great, and if fish so handled reproduce as hardy a stock as those that have lived under natural conditions.

Just before leaving the rivers, the parr lose their bands and as silvery smolt enter the third age of salmon.

Smolt. (Derivation uncertain: originally Scandinavian and Norse forms. Relationship to Old English smolt, smylte is very doubtful.) The smolt go out with the spring flood and as their

river life is short and spent during the periods of ice and high water, they are not very much in evidence. Gaining the tideway or shoal coast water, they remain for a time adjusting themselves to their new water conditions, as sudden transition from fresh to salt water may be fatal. They are from time to time taken in nets off the coasts of Scotland and Norway, where salmon of all ages seem to stand on and off, and in small numbers enter and leave the rivers for no manifest reason. The bulk of the smolt quickly disappear, to return as adult fish or as grilse in the fourth age of salmon.

Grilse. (Of unknown origin. Compare Old French grisle, grey. Some forms may perhaps represent a Scandinavian synonym; compare Swedish gralax, literally grey salmon.) The name grilse is applied not only to small fish below the weight of five, six, seven, and eight pounds or more, according to locality, but to salmon on their first return from the sea, which makes the use of the term arbitrary and contradictory. In all probability the word originally designated the females of questionable maturity and mature males with bifurcated tails, whose identity was so long confused with that of the sea trout. Why these fish come into the rivers is another of the many unex-

plained actions of the salmon, for the females may not be capable of breeding and the grilse may exhibit a fondness for some streams and enters others only in small numbers. It may be that certain fish seek fresh water to check over-rapid development of their reproductive organs, or it is possible that they are all merely victims of their roving dispositions; the ideas are equally fanciful or serious, as one may choose to regard them.

Ounce for ounce, the grilse has more fight than any other fish that swims freshwater, and if it carried the speed and gameness of youth into the heavy weight class of age, the captor of a 20-40 lb. salmon would have a hard battle for his trophy.

Entering the rivers singly or in schools, grilse give every evidence of enjoying life and though they often lie in shadows of the rocks, they spend most of their time in active investigation of underwater affairs and in taking wild leaps into the air. Their restlessness makes it almost impossible to put a fly outside their zone of activity and is the cause of many a grilse fatality, as they will even leap at the lure while you are recovering your cast by hand.

What to do with these small chaps has puzzled most anglers who respect their gameness and think

that a salmon tomorrow is better than a grilse today. Against the average salmon gear, they have absolutely no chance, and if given any room to play, they become so exhausted, that when unhooked and released in the stream, they float off on their sides or backs and frequently drown. On the other hand, if they are reeled in rapidly, they take a large quantity of water and get such rough handling that they are often unfit to be returned, so in either case, they are the victims of their own undaunted courage.

Except for their activity and the possible inability of the females to spawn, the river life of the grilse is much like that of the salmon, though they do not linger so long and are more apt to go in and out of the stream. From the scale rings, it can not be told whether a given fish did or did not enter fresh water as a grilse nor is there any scale marking to fix a definite boundary between grilse life and that of the fifth and last age of the salmon.

Salmon. (Derivation: Latin, Salmo (n), a salmon; lit. the "leaper" from salire, to leap.) By salmon should be understood a fish with truncate tail and generative organs fully developed, but as has been said, the classification is often an arbitrary one, owing to loose application of the

term "grilse." On the eastern side of the Atlantic, the fish swim in and out at nearly all seasons and are taken in drift nets off shore. In the Western Atlantic, they seem to come to the rivers and stay, though doubtless many do go back and forth to the sea several times in a season. It is assumed by some that the fish follow certain ocean currents and are late or early, many or few, as the temperature of such currents varies from year to year.

The influence of temperature on spawning, for which purpose the salmon come to fresh water, has been considered in detail by Gurley who says that "the significant fact in the temperature relations of fishes is the distribution of spawning with reference to the temperature zodiac," further—"there are two kinds of fish, those that spawn in warming water and those that spawn in cooling water,—of the Salmonidæ, all but two spawn in cooling water, —for a given species, the temperature relations which determine its migration and probably also its geographical distribution are the same as those which determine its spawning. The fish is stimulated to spawn by warming water and stimulated to migrate by warming water and vice versa for cooling water."

These parts of Gurley's theory are given in detail

for the interest they may be to salmon fishermen whose experience has familiarized them with the location, temperature and drift of ocean currents, and to those who have kept records of river temperatures. Gurley's theory is borne out to some extent by the time of spawning of the Atlantic salmon, which occurs during the late summer or early fall in cooling water; but just how far the migrations of this fish are so governed is problematic.

In regard to river entrance, it has been shown by Calderwood that the waters of Scotch rivers are colder than those of the ocean during winter, of equal temperature by the month of April, and warmer from April to September.

The approximate time of the salmon's return coincides in general with that of the stock from which they have sprung, though exceptions to the rule are numerous and occasionally disconcerting, as in the case of a Nova Scotia river whose planted fish are returning in late summer, after close of the fishing season.

Casual examination of scale reading statistics will show that salmon of all ages from 5-10 years return for the first spawning, and from this it might be inferred that the fish acquire the power

of reproduction at any time from mid-life to old age. Furthermore, such statistics will show the infrequency of second and third spawning, for of 4,391 Wye salmon, 257 spawned once, 17 twice and one, thrice, and in a collection of 5,000 scales, only one set showed 3 spawning marks.

It is difficult to attribute the differences in the spawning ages of salmon to variation in individual development, when most other vertebrates of such low order mature with a great degree of uniformity. In all probability, if the fish are over developed, too thin, too lazy, or too far from the streams, they relieve any discomfort from the accumulation of milt and roe by expressing these elements on the sands of a submarine garden, or the crest of an ocean wave; if, in any year, all conditions of body and environment are harmonious for breeding, they seek the streams, whether they be five or ten years of age. The relative number of second and third spawners, however, is governed by other factors and the principal one is the exhaustion of first spawning, from which comparatively few Atlantic salmon and no Pacific salmon recover.

Another interesting feature connected with the spawning fish is the difference of weeks or months

in the time of their arrival, though all ripen and spawn at the same time. Here again, one must take refuge in the theory of inherited instinct to return in April, May, June or July, as the case may be, or assume that fresh water exercises some governing influence on the development of the sexual apparatus.

The growth of salmon during their sea life is indicated in the tables compiled by Dahl and though they might not apply to uniformly small fish, they give an excellent idea of the rapidity with which salmon are able to take on weight and increase in length. Roughly translated into pounds, ounces and inches, they show that grilse (one year in sea) average 3½ lbs.; medium sized salmon (two years in sea) average 5½ lbs.; large salmon (three years in sea) average 20 lbs. The length of the fish is indicated in a composite table used to demonstrate the effect on growth of exhaustion of spawning.

In comparison to the accurate estimates of Dahl, it is interesting to read those given by Pennell in 1864. He says that "at least in many cases, smolts migrating in May or June returned as grilse, sometimes within five, generally within ten weeks, the increase in weight being 4-6 lbs. The

grilse spawn, go back to the sea and return next spring as salmon, with a further increase of 4-12 lbs. Thus, a fish hatched in April, 1854, marked as migrating in May, 1855, was caught as a salmon of 22 lbs. weight in March, 1856. Fish going out as kelts in February or March return, in at least many cases, in 4-5 weeks as clean fish with an increase of 7-10 lbs." Whether one accept the well controlled figures of Dahl which accord with those published in Scotland, or the estimates of Pennell, it is very evident that the growth is rapid from ounces of smolt to pounds of grilse and salmon, and it speaks for mass feeding on nutritious food which can be obtained with small expenditure of effort.

Arriving off the river mouths, the fish remain for several days accustoming themselves to the feel of water, its decreased salinity, and decreased buoyancy. It may also be that during this time the air bladder is inflated to meet new swimming conditions. When the fish start up stream, their progress is rapid or slow as they desire, for it is said that they can do 20-30 miles a day in river water free of obstacles, while of course they may only move from one pool to another. If bound for a tributary, the travel is usually direct to its

mouth where the fish sometimes lie for several days. If the water in their own river is not to their liking they will at times move up the main stream.

According to Calderwood, the Scotch salmon will not enter a tributary until the temperature of its waters approximates that of the main stream and the fish move faster in cold than in warm water. The author does not know how closely these conditions govern the movement of the Western salmon, but it is a matter of common observation that high, cool water means good fishing and low, warm water the reverse, while irrespective of water or temperature, more and larger fish are seen in the rivers every September—by the guardian.

Much of the travelling is done in the rivers at night and the beginning of up-river movement usually occurs just before dusk. At this time, the fish become restless and frequently the surface of a pool is alive with leaping forms; some take the jump with body curved, which brings them back into the water head first, while others throw themselves out and come down with a resounding smack. Rivermen say that the fish jump to get a look at the country before starting on their journey and this is as plausible an explanation as any,

though it does not account for the many evenings when the water surface is undisturbed.

A hooked fish jumps to loose himself, but why the free fish leaps is a mystery which will probably never be solved. During the day, most fish lie in the pools behind rocks or ledges that break the force of the current or give shade. Seen from a distance and at certain angles, they are so blended with the color of the background that only a well trained eye can tell the difference between a fish and a shadow, as some well known dry fly fishermen apparently do not realize.

It has been suggested that the motionless fish so often observed in salmon pools are asleep and though this cannot be disproved, most men who have tried to take them are convinced that if they do sleep, it is with both eyes figuratively as well as literally open, for with very few exceptions, they invariably shift when approached. At intervals, the fish nose around on business of their own and will sometimes jump if you slap the boat side or the water with a paddle. Occasionally their actions are such that one is almost convinced that they have a degree of intelligence but these instances are usually associated with the failure of a carefully conceived plan for the fish's capture.

The most spectacular performance of the salmon is his ascent of water falls and now that some of our keenest sportsmen find more pleasure hunting and fishing with moving picture cameras than with guns and rods, we can anticipate with interest a slowed down film that will analyze the movements of a salmon jumping a water fall. At the foot of nearly every water fall is a pool in which the fish lie and rest until ready for the jump.

When prepared, they take off from a varying distance, leap through the air and strike the water sufficiently near the top of the fall to be carried over its crest by their momentum and convulsive motions of the tail fin. If not successful, they tumble back into the pool and try again until exhausted. Just how high they are able to go has long been a matter of controversy but we know that they can surmount a perpendicular fall at least 18 feet in height, as is proved by the statement of Dr. Morris, an excellent observer whose testimony does not require substantiation, even by the good photographs which he publishes.

At the spawning beds, the sight is a curious one, especially when the water is shallow. Here are seen swarms of fish, some digging, some shovelling

gravel into the troughs they have hollowed out, some spawning and many of the males rushing at one another with mouths open and with every fin flutter suggestive of viciousness. On the outskirts of the restless throng and frequently sneaking into it are expectant trout who have an infinite capacity for salmon eggs and would take them before they fell to the gravel, did not the watchful salmon chase them away. After all milt and roe have been cast, the exhausted and emaciated fish linger for a while in the vicinity of the gravel heaps, or redds as they are called by the Scotch, then for the most part return to salt water. Those that remain over the winter, go down in the spring as kelts, black, cadaverous fish with heads seemingly enormous, and slank, slimy bodies, repulsive to themselves and abhorred by the anglers.

Thus are the five ages of salmon—First the helpless alevin, being rolled by current from one rocky crevice to another; then the black barred parr, nimbly seeking his insect food; next comes the silvery smolt, keen for adventures of the sea; then the frolicsome grilse whose quirks and gambols delight the eye; and last the salmon with mission fulfilled, taking a final journey to salt

water where perhaps sans teeth, sans eyes, sans everything, he dreams of

> "Rivers making way through nature's chains
> With headlong course into the sea profound."

CHAPTER VI

FRIVOLOUS AND OTHERWISE

WERE a log of the Ark available, it would probably contain certain entries to the effect that Ham, Shem and Japheth spent their off watch angling for catfish with bait from the chicken hold, presumably feathers, as fowls were not expendable property on that ship. If these Biblical tars did not invent the artificial lure, it must have appeared shortly after their time, as one cannot believe that two thousand or more years passed before the sprightly tribes of the earth discovered that a fish could be fooled. However, who made the first artificial lure and its slow development from the Greeks, described by Aelianus, is a matter of little consequence, as it remained for the Scotch to perfect that feathered fantasy, the salmon fly.

In the early years of Scotland, the clan with the gayest tarletan made the gaudiest flies and the wearer of an unusually bright kilt had to sleep in it when near a salmon stream. But evil days fell upon the land and its sons began to travel and bring

home fine feathers and tinselled cloth inappropriate to the climate and offensive to the religious dignity of the race. So a bawble too braw for the kirk became the makings of a salmon fly with such arrangements and additions as might appeal to the alcoholic imagination of a gillie, or the mellow humor of a laird.

With flies produced in this manner, anything approaching classification would have been impossible, had the first tourists not confined themselves to conventional vintage routes and returned with feathers plucked from the same birds and cloth cut from the same bolts. As it was, there appeared certain bright and drab creations, more or less uniform in composition and named Jock Scott for the maker (?) or some kind of a dose if possessed of unusual killing powers. Such flies brought willing fish, and the dour Scotch are too canny to imagine that anything will move the unwilling ones, so they were content with their labors and the returns therefrom.

Unfortunately, there are and always will be in the world, a number of people who insist on trying to paint the lily, hence by English, Irish, Canadian and American "fly cubists," we have had foisted upon us, multitudes of hybrid flies named for their

TROUT vs. SALMON

originators, or for some stream to whose fish it is fondly imagined they prove unusually attractive.

The evolution of the trout fly has been along more or less well defined lines for they are supposed to resemble to some extent the flies and insects upon which trout feed and by which they are apt to be attracted. Dry flies in turn are the perfection of artifice, fall lightly and are cast for the edification of a selected fish. Salmon flies on the other hand resemble nothing in nature and may be smacked around at random or dropped with skill in the hope that some deluded fish will hang himself on the poorly concealed hook—and strange to say, they often do.

Why the salmon takes a fly, all anglers know, but their ideas differ. For example, it is believed by some that the action is an exhibition of anger on the part of the fish. This is apt to be the theory of a suspicious man, one who never loses his own temper but may in the affairs of life, observe a lack of self-control in most of his fellows. He pictures the salmon as a sulky, vile-natured brute, trained in sea combat to attack things and destroy them. When it comes into the rivers, the nastiness of its disposition is increased by strange surroundings and interruption of its food supply. As a re-

sult, it lies in wait for a particular salmon fly. Horse flies, bumble bees and what not may float undisturbed and many salmon flies pass unnoticed, but just cast the particular fly against which it has a grudge and the fish will immediately pounce upon that fly and attempt to tear the feathers out.

Others are convinced that the fish is playful, humorous, full of joy at being in the sparkling river water. If not, why then does it dart hither and thither, leap into the air, and flourish its tail after the manner of an exuberant calf. Of course, it is trying to "lark" with the fly, for notice the gaiety of its approach and the twinkle in its eye as it springs at the lure. Why does it not take all flies? For the same reason that a child does not like all toys. You must study its tastes, try a dark fly on a bright day as a restful contrast to the glare; a bright fly on a dark day to suggest cheer; remember that large fish usually like large flies and small fish like small flies. You may have to exercise some patience but you will eventually find a little playmate to which the fish will become inseparably attached.

There are many who think that the fish believe a fly to be something that they can eat and so go after it, at times with a rush and at times so easily

that their presence is first made known by a weight on the line. The opinion has been frequently expressed that a salmon fly dragged across the water resembles a form of sea food upon which the fish has been accustomed to feed, such as shrimp. It is not impossible that in their sea homes the fish have lived in light and shadow sufficiently diverse to give them varied impressions of the color of shrimp; or the crustaceans may gather on their bodies several pigment particles, which would account for the attraction of different colored flies.

That every fly does not attract may also be attributed to the fact that the motion imparted to the fly by current or waving rod is not always similar to that of a swimming shrimp. Another form of food found in salmon fresh from the sea is the sand eel, and to make a salmon fly give an imitation of a sand eel is the acme of angling art.

Every one has noticed that there are periods when fish strike actively and at almost any kind of a fly. If there are a number in a pool, they will all begin to move at the same time and all lose interest at the same time. This may occur on any day, at any stage of water and in any temperature and has been attributed to sudden barometric changes which are followed by uncomfortably

rapid expansion or compression of gas in the swim bladder that make the fish restless. Such an idea once suggested itself to the author, and an attempt was made to verify it at a time when salmon fishing had become a very complex business.

During that season fish were being opened, a stop watch was carried to find if it really did take a minute a pound to kill a salmon, and the results of dividing the square of the length of the fish by one half its circumference, or some equally complicated formula to get its weight, could not be made to tally with a generous pair of Halifax fishing scales.

However, four daily barometric readings were made and charted, to determine whether a diurnal variation existed in that latitude, and there did. Strange to say, the slight barometric change occurred in that hour which had attracted attention as being the one time of the day when fish would invariably rise. As a consequence, there was much rejoicing on the apparent brink of a discovery, unique in the annals of salmon fishing, but unfortunately, it could not be verified in succeeding years, for while the barometer continued its uniform daily excursions in settled weather, the introduction of daylight saving time by the Maritime

"AND NEAR THE BRINK OF TRENT OR AVON"

Provinces completely upset the morning habits of the fish.

Thus, discussion frivolous and otherwise might be continued indefinitely, for its limits expand with each addition to one's circle of angling acquaintances and each season on a salmon stream. It is to be encouraged, as even casual interest in the salmon often leads to fondness for the fish and a desire to further conservation and protection, not only of salmon, but of all game animals that roam the earth or swim its waters. For the angler, the riverman and the netsman, it is hoped that methods of protecting salmon will each year become more efficient, to insure continuance of the silver stream, that now gladdens the eye and weights the pocket.

Fortunately, amongst anglers, the killers are decreasing, and in their places are appearing a new race of sportsmen, men content to take a fish for the skillet, or preserve its image on a motion picture film. These are the happy souls who love the sun shot peaks, the prairie, the lake, the river, and the clean, fresh wind that sweeps over all. With such as they—

> "Let me live harmlessly, and near the brink
> Of Trent or Avon, have a dwelling place;
> Where I may see my quill or cork down sink
> With eager bite of perch, or bleak, or dace,
> And on the world and my Creator think."

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